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National Fire Protection Association

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Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

Photograph by G. R. Swain, photographer to Near East Research of University of Michigan.

View of Constantinople from the city wall near the Adrianople gate looking east. (See Great Fires in Constantinople, page 118.) In the right background is the Sea of Marmora. In the middle ground one of the areas of the city laid waste by fire is visible. This is the section noted F on the map, page 119.

The Quarterly

Vol. 20 October, 1926 No. 2

What Price Attention?

Nobody except the advertising expert knows what price must be paid to arrest public attention. Contrast, variety, change, are so omnipresent in America that education, in the wider sense of the term, has ceased to be a schooling through experience and has become a mere bombardment of the senses. For reflection, for the weighing of impressions, the indulgence of a philosophical habit of mind, our civilization has small leeway.

These observations are induced by the experience of the sponsors of the N.F.P.A. field engineering service in their appeals to American merchants and manufacturers for subscriptions for maintaining this work. It is obvious that many persons receiving these appeals do not sense their import, however clearly the subject may be set forth in the sponsors' letters. A statement of the economic significance of the fire waste and the necessity for its abatement brings an amazing number of replies to the effect that the writer looks carefully after the hazards of his own property, is well satisfied with his insurance protection (either "stock" or "mutual") and is therefore not interested.

It is evident from such a reply that although the letter of which it is an acknowledgment is written by a prominent and influential citizen whose standing in the community should warrant most careful attention being accorded to it, it really registers less of an impression upon the mind of the recipient than a reiterated advertisement of a popular cigarette; adequate attention to the contents of the letter is not given. So far as the economic significance of the fire waste is concerned such citizens appear contented enough with their uninformed state.

The explanation of this state which the advertising man would make would be that the unresponsive citizen hasn't been "sold" on the proposition; that is to say, the idea hasn't been hurled at him often enough and long enough to penetrate his consciousness and make room for itself in the gallery of his comprehension. Present American society as a whole closely parallels the experience of the young child. An immense mass of impressions is being constantly hurled at it, disjointed, glittering, inchoate.

They come so thick and fast that there is no time for synthesis, no time for answer to the first "why" before the second query springs to mind. The habit of our daily living renders escape from the multiplicity and the transitoriness of impressions impossible. The city streets we walk fling their wares at us in an emblazonment of light by night and color by day that forces the eye and mind from the one to the other; the country roads we travel have their billboards strategically disposed to catch the errant fancy at every hilltop; the subways and surface cars present an embryo picture gallery in advertisements whose proximity inevitably draws the glance from one to another; the newspapers, with edition succeeding edition, bring tomorrow's perplexities before today's have sunk into the consciousness. The parts in our American civilization are greater than the whole; the whole, indeed, for great numbers of the people is non-existent except as a vague something brooding confusion. Our civilization incites to thinking by the profusion of its manifestations, and by the very insistence of that profusion confounds and deadens thought.

* * * * *

The Florida Hurricane. The Florida hurricane, the tremendous destruction and loss of life, the relief measures and the sympathy extended to the sufferers have been fully covered in the newspapers; no additional comment on the details is appropriate in the QUARTERLY. Unlike conflagrations, this disaster could not have been prevented; the hurricane cannot be controlled. There is no suggestion, as in the case of a devastating fire, that the energy devoted to relief might better have been expended in prevention.

It is indeed fortunate that no sweeping fires came in the wake of the storm to make the destruction complete. Fire frequently follows collapse of buildings in earthquake or storm and under the conditions prevailing in Florida cities it might have been impossible to check an incipient conflagration.

* * * * *

Work for Committee on Farm Fire Protection. In the year 1925 fire caused a property loss in excess of $150,000,000 to farm property throughout the United States. This sum, which is equivalent to one-sixth of the net income of all the farmers in the country, would pay their annual interest on all borrowed capital and leave a tidy surplus of $50,000,000 as a sinking fund to pay off the principal.

The loss is equal to one-half the value of all the crops raised in Indiana for the year, and amounts to $26.29 for every farm throughout the country. It approximates the total value of the entire agricultural output of such States as Michigan and South Dakota, and amounts to about

three times the annual budget of the Federal Department of Agriculture with its 20,000 employees.

Professor Christie of Purdue University recently pointed out that the fire loss on farms, in terms of lumber depletion, amounted to about 740,000,000 feet each year, or one-eighth of the total output of the lumber industry.

Much of this loss is avoidable, according to authorities, who maintain that while isolation is perhaps the principal factor, fire prevention education has not advanced as rapidly in the rural sections as it has in the cities, carelessness playing a major part in the yearly toll exacted by fire.

* * * * *

The New Jersey Explosion. The munitions explosion and fire at Lake Denmark, New Jersey, in July, was primarily an explosion of ammunition rather than a fire and for this reason has not been included in the fire loss totals for the month prepared by the *New York Journal of Commerce*. The disaster, however, is of interest from the viewpoint of fire prevention as it was caused by lightning, was accompanied by a number of fires and because of the great loss—21 lives and property damage variously estimated between $75,000,000 and $100,000,000.

The major part of the damage occurred on government property, the Lake Denmark Arsenal of the Navy Department. As this was government property the disaster was investigated by a Navy Court rather than by the civil courts. The Court duly concluded its investigations and reported that no one was to blame. The *Engineering News-Record* in commenting editorially upon this report asks several questions and makes interesting observations upon the situation. Quoting from the editorial captioned "Once More the Navy Exonerates Itself":

> So far as the Navy Department is concerned the explosion of the Lake Denmark Arsenal is a thing of the past, an unfortunate but unavoidable incident. The Navy Court having determined this, the Navy Department has set about making its plans for new and safer arsenals. That is as it should be from the point of view of the Navy Department. But for a lot of people who lost family or home, or who went through the hell at Lake Denmark—both inside and outside of the Army and Navy—the matter is still a very live issue. For their benefit as well as those who may be threatened with a similar menace from other arsenals elsewhere in the country there are a few questions which should be put to the Navy Department now before changes in personnel make it more difficult to answer them.
>
> Points which seem to us to be of major importance do not appear to have been touched upon except lightly, as if of minor importance. The court found no one, neither individual nor government department, responsible for the vast destruction of life and property. The

Court found the accident was caused by a force beyond the control of man; everything humanly possible had been done to protect the arsenal from lightning, and despite these efforts it was set off by a stroke of lightning.

But when the Navy Court had made its determination as to the cause and methods of protecting against the ill-effects of lightning it only had begun rather than completed a proper investigation of the Lake Denmark explosion. Granting that man cannot control lightning or direct it into safe paths, there still remain these points to be determined upon:

Who was responsible for such a vast and, had the United States been subject to New Jersey state law, illegal concentration of explosives in a square mile of territory?

Who was responsible for having this explosive material housed in buildings with combustible framing and fittings?

Who was responsible for explosives being carelessly housed with projectiles and depth bombs instead of being segregated to reduce the risk of all being set off in case part was set off?

And who was responsible for there being neither barricades nor adequate spacing between buildings to stop the spread of destruction?

In answering these questions the Navy should not be permitted to claim that what it says now is in the light of knowledge gained in the Lake Denmark explosion, for knowledge on these points is of long standing. The Navy may have gained added knowledge in these matters but no new knowledge. The engineering world knew that the storing of explosives in non-firesafe buildings was increasing the risk. The Navy surely should have known it also. It knew, or ought to have known, that barricades or wider spacing between the buildings would have reduced the risk. It knew years ago just as its Court of Inquiry now reports that the various classes of explosive material within the arsenal should have been segregated, and it must have known that to pile up a lot of old and partly useless excess material left over from war days along with its necessary supplies for the part of the Navy operating in the New York district was inviting trouble. These actions cannot be disposed of in the convenient classification of "Acts of God." They are the acts of some person or persons in the Navy Department, not done maliciously but with that sort of stupidity which any bureaucratic organization develops.

* * * * *

Gasoline and Cigarettes. If gasoline vapor ignited every time that it came in contact with a lighted cigarette or cigar, there would be several thousand less gasoline filling stations and filling station operators than there are today. Those who observe the very frequent disregard of "No Smoking" regulations in garages and other buildings where gasoline is handled are amazed at the carelessness shown and wonder what Providence protects the smoker from the logical consequences of his act. Gasoline explosions and fires are frequent, but in view of the reputation of gasoline and the prevalence of careless smoking

it may be difficult to explain why there are not more of them.

The N.F.P.A. Executive Office recently received an inquiry from a member that had encountered a professor who doubted the possibility of ignition of gasoline vapor by a lighted cigarette or cigar and who performed an experiment to prove his point, actually extinguishing a lighted cigarette with gasoline.

In an endeavor to secure data to convert this skeptic, a review was made of records of fires caused by careless smoking in the presence of gasoline vapor. A large number of such fires are on record, but in the majority of cases the evidence does not prove conclusively ignition from glowing tobacco rather than from a match used to light the cigar or cigarette. No one seems to be skeptical of the fact of ignition of gasoline vapor by a match flame. The only question raised has to do with ignition by burning tobacco. As evidence that explosions can and do occur from a lighted cigar or cigarette with no other source of ignition, there is one clear-cut case in Denver where a man opened the door of a closed garage while smoking a cigar and was blown across the street together with portions of the garage structure.

Apparently the professor's experiment failed to produce ignition because the temperature of glowing tobacco, several hundred degrees lower than that of a match flame, is only slightly above the ignition temperature of gasoline vapor. Commenting upon this, Chairman A. H. Nuckolls of the N.F.P.A. Committee on Hazardous Chemicals and Explosives, writes:

> In general, gasoline vapor in air is not readily ignited by the glowing end of a cigarette. The temperature of the cigarette end is above that required to bring about ignition of gasoline vapor in air under favorable conditions, but usually when the glowing end of a cigarette is exposed to gasoline vapor-air mixtures the conditions are such that the gasoline vapor is not heated to any dangerous degree, owing to convection currents produced by the change in density of the vapor as soon as its temperature is raised.
>
> The result is that the heated vapor is passing upward or away from the cigarette and before attaining its temperature is being replaced by cool vapor unless the system is so enclosed that each cycle adds to its temperature. There are several factors involved in the process of ignition of a vapor by means of the glowing end of a cigarette or other heated object, including the nature of the container, convection currents, and the temperature of the cigarette end (or heated object) which heats the surrounding vapor and air by radiation and conduction, and there is a time factor in the latter process of heating which depends upon the gradient or temperature difference between the vapor and source of heat. The higher the temperature the more rapidly the surrounding vapor is heated and the quicker the cycle in which heated

vapor again comes in contact with or very near to the temperature source. There is also a time factor in connection with the movement of the vapor (convection currents) and it will be seen that if the temperature of the source is sufficiently high, these factors will become of secondary importance or negligible and ignition will occur.

The Factory Mutual Laboratories have investigated this matter and report that the temperature of glowing organic material such as tobacco required to ignite gasoline varies between 1300° F. and 1400° F. while the temperature of glowing tobacco is said to be between 1400° F. and 1500° F. The temperature required to ignite gasoline vapor, however, varies with the character of the gasoline and the type of ignition source. The Factory Mutual Laboratories report that where the source of ignition is hot metal, the temperature required may be considerably lower. In one experiment ignition was secured at a temperature of 285° F. where the source of heat was a hot copper plate in an aluminum enclosure. This leads to the theory that ignition of the vapor might be facilitated by particles of metallic dust in the burning tobacco.

While explaining the reason that smokers in the presence of gasoline often escape the penalty for their carelessness, all this is not to be interpreted as an excuse for any relaxation of vigilance with respect to smoking in hazardous locations. Gasoline is erratic in its behavior. It explodes when least expected and at other times does not ignite under seemingly favorable conditions. It can well be compared with dynamite, being similar in many respects. It is said that dynamite is sometimes carried in the pocket, dropped on the floor, and otherwise carelessly handled with impunity. Nevertheless, dynamite is not advised for household use. Gasoline should be treated with similar respect.

* * * * *

"Painting the Lily."

The practice among motorists of draining the oil from the crank cases of their machines at regular intervals is pretty well established. And 20,000,000 automobiles provide quite a supply of drainings. This waste oil can be re-refined and used again and in some of the larger communities enough drainings can be collected from filling stations to make such a salvage process worth while.

For several years Memphis has collected this oil and used it on marshes to combat the mosquito pest but most communities still throw the stuff away. Hence inventive genius has attacked the problem. An early manifestation of research was a fire in a New England city which proved fatal to two youths who were experimenting with drainings as fuel for an oil burner.

The latest use for these drainings conceived by some agile mentality

is recorded in a recent issue of the *National Petroleum News,* which reports that an enterprising San Francisco filling station owner sells the drainings as shingle paint to a local painter who specializes in small houses. The painter seems to feel that the oil gives the shingles the effect of creosoting at lower cost and aids in making the roof water tight. There then follows the amazing statement: "Being a lubricant and designed to stand great heat it is therefore safer for a roof coating than oils with a turpentine base."

The drainings contain a fair proportion of gasoline. Not content with an ultra-combustible roof of wood shingles—these must needs be saturated with a flammable liquid to make them worse! Of course, in time such a roof may dry out but meanwhile the owner has an A-1 flammable roof.

Cartoon reproduced from "Film Board of Trade Bulletin and Fire Alarm," published by Motion Picture Producers and Distributors of America (Member N.F.P.A.).

Your Fires Keep My Hair Long.

By Ellis Parker Butler.

Now and then you will see me with my hair so long it hangs down over my collar in the back, and I am wearing a tie that is all chewed up by the frequent insertion of my scarf-pin. I look like the last rose of summer on the way to the poor-house, and the reason is that my fire insurance costs me so much. It costs so much I can afford a hair-cut only once in two months and I have to wait until Christmas for a new tie.

The reason I have to pay such high fire insurance is because so many of you are careless with matches and cigarette butts. I have to pay for your fires, drat you! I have never had a fire and I expect never to have one. Years ago, about 1877, an aunt of mine had a fire in a basket of clothes she was about to iron, and she collected $2.14 insurance, and that is the only fire anyone in our family, male or female, has had in six generations. We steer clear of fire; probably one of us was burned at the stake in the old days and it taught us a lesson. Or maybe we are looking forward and feel that we will get all the fire we need later on.

I suppose our family has paid more in fire insurance since we first began paying fire insurance than our whole caboodle is worth today. That is because we usually own a $12,000 house with a $13,000 mortgage on it, but we have to carry $9,600 insurance on the house.

In 1870 the fire loss averaged $19 a minute, in 1926 it averages $1,084 a minute. That is fifty-six times as much as in 1870. If you keep on being as careless about fire in the same ratio, increasing fifty-six times every thirty-six years, the fire loss will be $57,420 per minute in 1982. I will be an old man then and I will come around and stick my toe in the ashes of your dwelling and say "I told you so!" Even $1,084 per minute is a lot of money; it is more than I earn even on my best days.

When I was a boy my aunt put my starched seersucker pants on me and sent me to Sunday school, and as the Mississippi River was on a rampage I walked down Sycamore Street to look at Pappoose Creek. As I passed Mulford & Cadel's sash and door factory a fellow who had stolen my sled the winter before was sitting under the loading platform among the shavings, smoking cigarettes. That was a devilish thing to do in those days, and I shuddered and went past quickly. The fire alarm sounded while I was in Sunday school and Mulford & Cadel's burned to the ground. The town lost an industry; the factory was never rebuilt.

Some years later, when the river was again high, I walked up past the Upper Saw-Mill to see the flooded area at Mad Creek. That day the Upper Saw-Mill burned, with acres of lumber piles, an enormous loss, a regular $1,084 per minute fire. The clay hillside above the plant was burned brick red and is so still, a third of a century or more later. The mill was never rebuilt; the town lost another industry.

The moral of this may be that I ought not be allowed to walk around and look at floods. It may be that people ought to be more careful with matches and cigar butts, but they won't be. I think the moral is that we should all keep flammable materials and liquids cleaned up and away from places where careless persons may set them afire. If this is done I shall be able to have my hair cut once a month and the world will be a more beautiful place, particularly in the neighborhood of the back of my neck.

Courtesy Factory Mutual Record.

Concentrated Sunshine Causes Fire.

This photograph records an unusual incident which occurred recently at the Corning Glass Works, Corning, N. Y., as recorded by the Factory Mutual Record, published by the Inspection Department, Associated Factory Mutual Fire Insurance Companies (Member N.F.P.A.). Broken glass reflectors had been placed in a wooden barrel in the yard of the plant, pending removal. On a hot July day the rays of the sun striking one of the pieces were reflected to the side of the barrel. At the point where the rays focused a hole was burned completely through. Attention is directed to this hole in the above photograph by the white circle around it. The men who discovered the burning barrel wanted to determine whether fire was actually caused in this manner so they shifted the reflector slightly and produced the burned spots adjoining the hole as shown in the illustration.

Great Fires in Constantinople.

By Professor Francis W. Kelsey,

University of Michigan

Returning to Constantinople at the end of 1919, for the first time since a visit in student days, I was greatly puzzled to find open spaces extending for many blocks in quarters of the city which I remembered as densely covered with buildings. A closer inspection revealed windowless shells of mosques with their minarets, abandoned and in ruins, and crumbling walls and foundations of other buildings which in places were partly covered by young vegetation. With effort the eye could trace partially obliterated thoroughfares threading these barren wastes.

It required only brief observation, supplemented by inquiries, to learn that this disheartening desolation in the midst of the city had been caused by a series of fires, which were on a sufficiently large scale to be properly termed conflagrations. The subject seemed worthy of investigation.

The results were startling. The statistics showed that in the twelve years since the beginning of 1908, more than one-fourth of the area of Stamboul, the most ancient part of Constantinople and still the heart of the city, had been burnt over, and was still lying unrestored and desolate. The total area of Stamboul which has been built upon is reckoned at 8,500,000 square meters [about 3¼ square miles]; the burnt areas—making no account of small isolated fires—aggregated 2,265,000 square meters [about ⅞ of a square mile].

East of Stamboul, and separated from it by the Golden Horn, lies the quarter of Galata. Above Galata, on the crest of the heights, is Pera, which contains the European quarter. Though these and the other sections of Constantinople east of the Golden Horn have a larger pro-

Photographs which accompany this article are furnished through the courtesy of George R. Swain, photographer to the Near East Research of the University of Michigan.

Map showing the burned areas of Constantinople. Below is Stamboul, while above the Golden Horn at the right is Galata from which steep streets lead up to Pera. The areas burned are shaded. That designated A was destroyed in 1908; those marked B in 1911, the fire starting in the smaller area and leaping to the larger, while the next day the area C burned. Area D burned in 1912; E in 1915; F, the largest area, in 1918; and G in 1919.

portion of modern and more permanent buildings than Stamboul, a glance at the map will show how conspicuous are their burnt areas also.

It may be of interest to study more closely the succession of seven great fires indicated by the letters on the map. The first of these desolated the area in Stamboul marked A on the map. It started on August 26, 1908, and destroyed 1500 buildings. The second great fire commenced July 24, 1911, in the smaller of the two areas marked B, and leaped across to the larger area; it burned 2463 buildings. The following

The windowless shells of mosques, abandoned and in ruins as a result of the numerous sweeping fires which have devastated great areas of Constantinople. The area illustrated is the one marked F on the map, page 119. The foreground is in shadow as the picture was taken just before sunset, but the white minarets rising above the ruined and deserted mosques present a ghostly appearance.

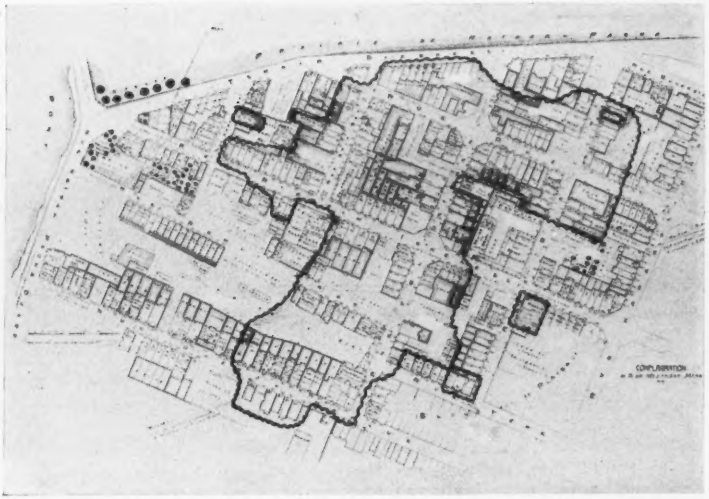
day the area marked C was burnt over. The area marked D was burned June 3, 1912.

The largest burnt area in Pera is that marked E on the plan. The fire started on July 26, 1915, a short distance south of the German Embassy, which occupies a dominating position on the Pera ridge, and spread southward, roughly paralleling the shore of the Bosphorus. It consumed 1400 buildings. The most recent great fire on the east side of the Golden Horn broke out on June 21, 1919; the burnt area is marked G.

The most fearful conflagration of all commenced on June 13, 1918, and swept over the area marked F. It cleared a broad strip from near the edge of the Golden Horn southward over the peninsula through the heart of Stamboul. It destroyed 8000 buildings and left desolate 1,100,000 square meters [nearly a half square mile], slightly more than one-eighth of the entire area of Stamboul devoted to buildings.

These areas of destruction by fire still in 1920 gave to the parts of Constantinople west of the Bosphorus an appearance in some respects resembling that of European cities which had been partly destroyed in the war. There was, however, this difference. In the war-wrecked cities of Europe, with some exceptions, walls were still left standing; in Constantinople there were whole blocks in which so little stone or brick had originally been used in construction that as one looked across the fire-swept area he had almost the impression of open country.

Since 1920 the fires west of the Bosphorus have been less serious,



The conflagration in Haidar-Pacha, the prosperous modern quarter on the east side of the Bosphorus south of Scutari, July, 1922. The area burned is outlined in black.

and not such as to require mention in a survey dealing only with the broader aspects of the subject. For the same reason it is not necessary to concern ourselves with the burnt areas in Scutari, east of the Bosphorus, which are impressive to the eye but relatively less important. But toward the end of July, 1922, a notable conflagration consumed several blocks of Haidar-Pacha, the prosperous modern quarter on the east side of the Bosphorus south of Scutari, where is the terminal station of the railway that runs the length of Asia Minor through Konia to Aleppo, then down through Damascus and Jerusalem to Cairo.

This fire started on July 26 and raged for two days and nights before its progress could be stayed; it continued to smoulder for a week longer. While the number of buildings destroyed, reported as 188, was relatively not great, they were larger in size, and 99 of them were of masonry, rated by insurance companies as risks of the best class. At the start there was, to be sure, some delay in fighting this fire; but it was attacked by modern methods, though under the handicap of an insufficient supply of water. Its destructiveness was caused by a violent wind from the northeast, which drove the flames down a slope from higher ground.

The fires of Constantinople have had their origin in a variety of causes.

The first cause is that in the old days suitable building regulations were not enforced. Leaving out of consideration the wonderful mosques,

View of Pera showing the contrast between the European type of construction along the higher part of the ridge and native buildings in the immediate foreground.

the government buildings and the homes of the wealthy, one observes that the great majority of the shops and houses in Stamboul and Scutari, and a smaller proportion in the other quarters of Constantinople, are wretchedly built and of "temporary construction." Though the roofs may be covered with tiles, wood has been so extensively used that in many places the fire hazard is greater than in American frontier or mining towns, where the streets separating the shacks are wider. Fire nests, consisting of groups of unpainted and run-down wooden buildings, may be found within a block of the two European streets of Pera, the Rue de Pera and the Rue des Petits-Champs.

In the old days, too, the fire protection was something worse than inefficient, and to it the spread, if not the starting of fires, has frequently been attributed. Before the Great War there was, to be sure, a military organization charged with the extinguishing of fires; but alongside of the military fire brigade there long continued in existence a civil corps of firemen, whose sole equipment consisted of a water tank supported by poles on men's shoulders and emptied by a hand-pump. When the moderate supply of water in the tank had been pumped out, it was refilled from one of the reservoirs which formerly stood at the corners of streets, as in ancient Pompeii, or, later, from water mains.

In compensation for their services these civil firemen enjoyed certain privileges. They paid no taxes on the products of any trade which they might follow when not actually engaged at fires, and they were relieved from other taxes. They were permitted to keep any effects rescued

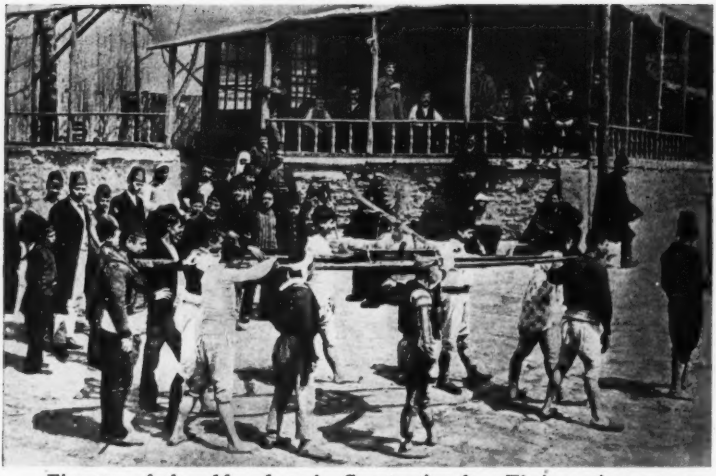
A typical fire-nest in Stamboul near the edge of the burned area marked F on the map on page 119.

from a burning building that they could carry away; the police would not interfere with them because they had no wages, and, besides, the police were afraid of them.

"The civil firemen," writes a correspondent in Constantinople, who has often watched their operations, "were a sort of private corporation, having at its head a chief who shared with its members the earnings and robberies. Even if the shares were not equal, it was natural that the chief should receive a larger portion than the rest. He was respected by the members of the corporation, and he protected them and provided them with work. In different quarters of Constantinople, however, there were different corporations, and sometimes these would fight when they happened to come into competition at the same fire; such fights were the result of each party trying to get for itself a bigger portion of the rescued goods or thefts.

"As a mark of distinction these firemen wore shirts of different colors representing different corporations; yellow, red, blue and white were the colors preferred. The uniform of the civil fireman—if such it can be called—in fact consisted only of a shirt and short white pants. Here and there a fireman had a colored handkerchief around his head, presumably as affording some protection against the heat of a fire.

"They used to run to all fires barefooted. They were very fast runners, too—swift like a horse. The same clothing served them in winter as in summer—in rain, snow, or sunshine, always the same; they were used to it and apparently did not suffer in consequence.



Firemen of the older days in Constantinople. Their equipment consisted of a hand pump and a small tank supported by poles carried on the shoulders of the men. The present fire department of the city is modern and motorized.

"These civil firemen belonged to the lowest class of native Turks, Armenians, Greeks, Tartars, and Kurds, with also a few Jews. It was a strong and courageous mob, but irascible and quarrelsome and feared by the population. As a matter of fact to designate a person of irascible and quarrelsome character, you call him here a *touloumbadjy,* which in Turkish designates one of these firemen and also means a low-down fellow."

The point of view of the firemen under the old régime might be stated thus:

It is the will of Allah that this place be burned, else the fire would not have started. The owner would lose all his effects if we did not rescue them. If we take them for ourselves, therefore, it will be no loss to him, and we need the proceeds because we cannot get enough to live on in any other way.

Under such conditions, we are informed, when a fire broke out warning was given to indicate the quarter in order that a man's friends might know that his property was in danger and rush to help him save his effects. And since the fireman's first duty, as he conceived it, was to himself, his main efforts were directed to salvaging, with the right to dispose of everything which the owner and his friends could not carry away in their own hands. The fire meanwhile was apt to run its course, unless sufficient bakshish was forthcoming or some public building was in danger.

A friend who understands Turkish tells me that he has seen firemen stand in front of a burning building and refuse to attempt to put out the fire until a bargain had been struck with the owner, fixing the amount of money that he would agree to pay. The belief is shared by many that if the indifference of Allah caused a dearth of fires for too extended a period, He might be reminded of the necessities of the firemen by starting a small blaze themselves in some promising quarter. Should this die out, they would be resigned to further long-suffering; but if a profitable fire resulted, "it was the will of Allah, whose name be praised!"

Before the year 1908, with which our survey begins, considerable improvement had already been made in the methods of fighting the fires; and not long after the beginning of the Great War, the Germans introduced an excellent system which they controlled until its close. Nevertheless it was under the Germanized administration that the most destructive conflagration of all, in June, 1918, devastated the central part of Stamboul.

The bad reputation of the Turkish fire-fighters of the old régime is perhaps in part responsible for the ready vogue of sinister rumors regarding the recent great fires. The fact that the largest burnt areas in Stamboul, marked A, B, D and F on the plan, are in districts inhabited chiefly by Turks, led to the charge that their secret enemies in the city were responsible for the destruction. On the other hand, it was suggested in all seriousness that the burnt area below the German Embassy, E on the plan, which was burnt over in war time, represented the beginning of the fulfillment of a deliberate purpose on the part of the Germans to beautify the part of the city between their Embassy and the water's edge. This reminds one of the rumor circulated after the great fire in Rome in July of the year 64 A. D., that the Emperor Nero had it started in order to clear the ground for a rebuilding of the city in accordance with his new city plan.

It is not necessary, however, to attribute the conflagrations to an incendiary origin. A comparison of dates brings home the fact that they have all taken place in the summer, when the heat of the sun makes the wood of the houses as dry as tinder. Popular report has it that fire alarms thicken when the fruit of the egg-plant, a favorite article of diet, comes into market; this is fried in oil, which, carelessly handled, may easily start a blaze in a small wooden kitchen, though of course the use of oil in cooking is not confined to any season.

However that may be, if one notices the shape of the burnt areas as laid off on our map he will see that in general they run north and south. An insurance expert informs me that all the great fires started at the north end of the devastated zones, and were driven southward by the

north (or northeast) wind, which sweeps down from the Black Sea and blows strongly in the afternoon of a large proportion of summer days. "The recent great fires are all due to accident," he said, "and to a lack of water for putting them out as they were starting."

The same expert is authority for the statement that before the War the burning of single buildings or small groups of buildings was for a short time systematically practised by an organized gang of criminals who, forming an alliance with the police, placed heavy insurance and started fires in order to collect it. One is not surprised to learn that at the present time the rate of insurance in Constantinople is abnormally high.

Nevertheless, today there need be no apprehension of a return to former conditions. Under the energetic administration of the new government, automobile fire extinguishing equipment has been installed with twenty-five motors. This is supplemented by motor boats on the Bosphorus, which are equipped to render aid, in case of necessity, on either side of the channel or on the islands in the sea of Marmora. The reorganized fire department has at the head of important sections former officers of the Turkish Army, who maintain military discipline.

The present system has been in operation more than two years, and its value has been amply demonstrated. In fact not long after it was installed a young American of my acquaintance ran to a fire which broke out in a July night in a three-story wooden building in the Turkish quarter below the principal hotel in Pera. He arrived before the fire brigade. He reported that though a strong wind was blowing, the fire department met the situation so well, and the pumps worked so effectively, that the blaze was isolated and was brought under control in a comparatively short time. He said that in point of efficiency the work of the firemen was as good as that of a fire department in an American city.

There is no occasion for surprise at the fact that in the burnt areas rebuilding has gone forward slowly, so that groups of blocks are still as barren of habitations as they were when they were first laid waste. It will not be forgotten that since 1908 political and economic conditions in Turkey have been much disturbed, first by the Revolution, then by the Italian and Balkan wars, finally by the Great War, with its train of consequences; and the removal of the Turkish capital to Angora was a blow to the prosperity of the city.

In the intervening years, again, the costs of building materials and construction so increased that, according to the estimate of an expert in 1920, about half of the owners of real estate in the fire-swept districts would have been unable to raise the money needed for rebuilding even if they had been disposed to rebuild. At the present moment, outside of the burned blocks in Haidar-Pacha, there is even less inducement to

A view over the Golden Horn and Stamboul, looking west from a point about 300 feet back of the American Embassy. Ramshackle wooden buildings stretch from the foreground down to the wharves.

put money into construction. A large part of the buildings in Constantinople were owned by Greeks, Armenians, and Jews. Of the Armenians and Greeks many have left the city, and the Turks naturally see no reason to spend money for new buildings when they can buy up, at a reasonable or low price, property left vacant by the former owners; and the Jews under present conditions see no prospect of a good return on such investments. As a rule the new buildings reflect the economic situation and are not of a high quality.

There are, however, conspicuous exceptions. One is an apartment building in Stamboul, which belongs to the city and is a model in its adaptation to local conditions. As a guest at a Turkish wedding I had a fortunate opportunity to see its arrangements. This building was constructed in four sections, each of which contains thirty-five apartments of three to five rooms, with kitchen and bathroom. Of the one hundred and forty apartments all but six are rented; these are utilized for administration, for a dispensary and for a doctor's office. Within the building also is a repair shop, to which needed repairs are reported. Underneath is a mortuary chamber where the dead, according to Turkish custom, are washed and dressed for burial; for it is not permissible to render this last service in rooms used for habitation. The apartments are abundantly supplied with windows and lighted with electricity.

The effect of the great fires in Constantinople upon living conditions has been noteworthy. In 1908 the population was estimated as between eight and nine hundred thousand. Just after the close of the War, the city was crowded with refugees, and the population was reckoned as

between twelve hundred and fifty and thirteen hundred thousand. In 1919 and 1920 the living conditions were shocking. While the population had increased not far from thirty per cent, on a conservative estimate the housing accommodations had been reduced at least fifteen per cent below the total available at the beginning of 1908. The congestion of living and of street traffic would seem unbelievable to one who had not a first-hand knowledge. In the foreign quarter for a time Constantinople became far the most expensive capital of the world to live in.

At the present time the population is estimated as between seven hundred and seven hundred and fifty thousand. One reason for the reduction is that in the "exchange of populations" a large portion of the repatriated Turks arriving in Constantinople preferred to cross over to Asia Minor, and did not remain in the city to take the place of the Greeks who had left it.

Whatever its political vicissitudes, Constantinople cannot fail always to be a great city because it is placed at the intersection of two important trade routes, one running east and west and linking Europe with Asia, the other running north and south and bringing the commerce of the world into relation with the ports of the Black Sea.

The "Home Safety" Exhibit

Sesqui-Centennial Exposition, Philadelphia.

In this period in which the American people have lost, at least temporarily, the habit of reflection and the written word has ceased to register in the common mind, the "home safety" exhibit at the Philadelphia Sesqui-Centennial Exposition, designed by Mr. Charles J. Strobel and financed by the Insurance Company of North America, is undoubtedly as effective an appeal to the public as could be projected.

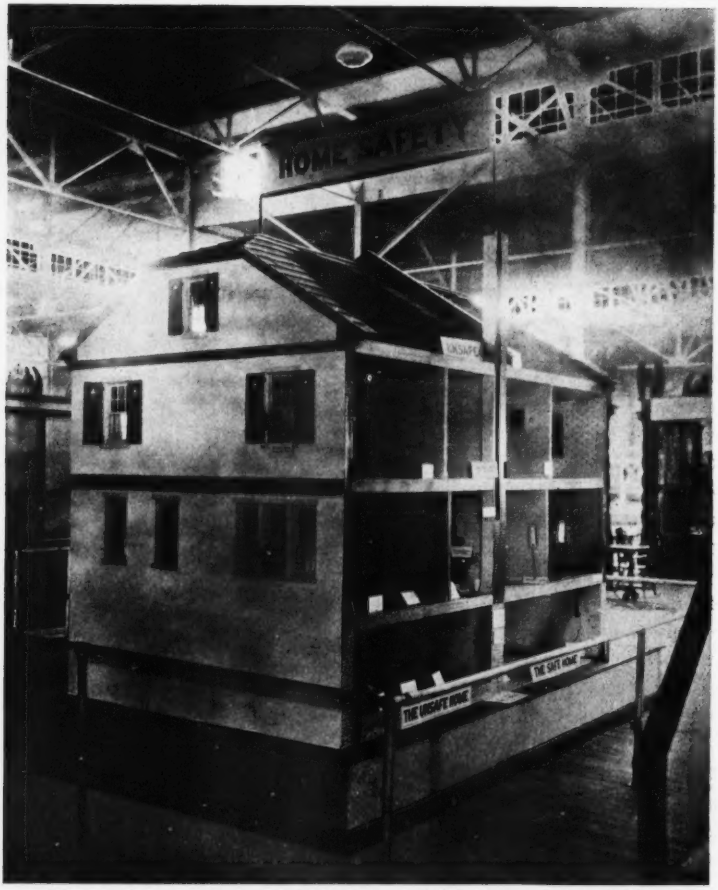
All day and evening the crowds circle the exhibit and discuss the contrasted picturizations of the good and bad features, each person deriving such complacency from his inspection as may be warranted by the good points of his own home, and the willingness of adjacent people to hear about them.

In effect there are displayed models of two houses, one safeguarded against fires and accidents, and one not. A single unit comprises both for economy of space.

The overall dimensions of the complete unit are 13 ft. x 6 ft. 6 in. x 8 ft. 6 in. high and show basement, floors one, two and attic. In one of the houses hazardous conditions are shown; in the other good practices both in fire and accident prevention. If reference is made to the plans and photographs it will be noted quite a few conditions are shown, but as work progressed on the houses numerous other features were added.

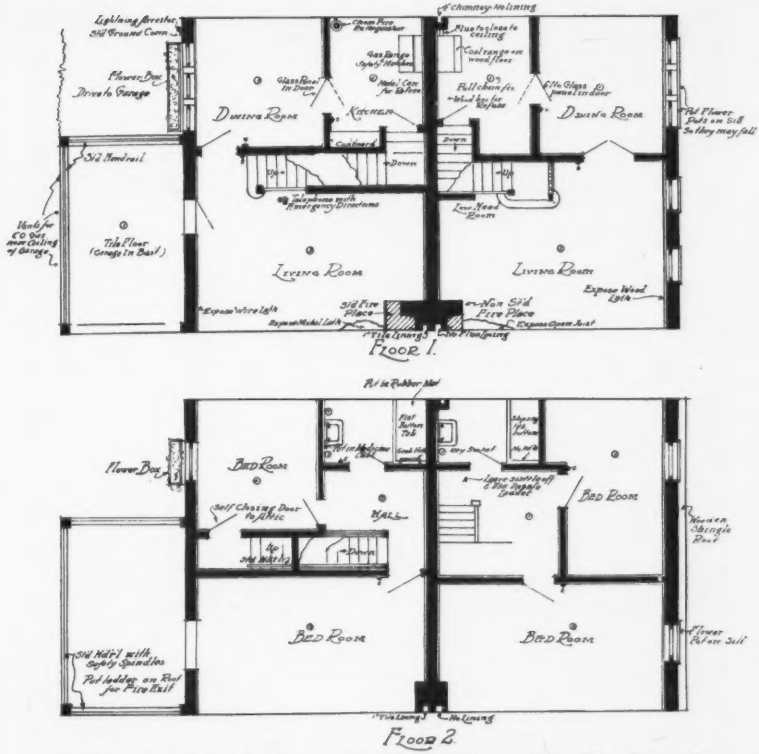
The effective viewing of the house model by the public required considerable thought and it was decided to place the model on an 18 in. table so as to eliminate the necessity of people bending down to see into the basements. To see into upper floors and attic and to view the upper portions, two platforms 44 in. high with stair approaches were erected, and at a convenient height on the wall space adjacent to these platforms are displayed safety bulletins and fire pictures which attract their share of attention.

In the contrasted house models building construction is of course a primary feature. The one has wooden shingles, the other fire-resistive roof covering; one partitions of metal lath, the other wood lath; one self-releasing floor timbers, one not. In the non-standard house the floor joists extend into the brick of the chimney, the hearth is improperly constructed, there is no lining in the chimney flue, no spark-screen, the basement ceiling is unplastered, and the heater smoke pipe too close to the floor joists, the kitchen range has no floor protection nor is the ad-



The model as seen on entering the exhibit space. The platform on which the house rests is high enough so that persons standing on the floor can see into the basement without bending down. To afford clear view of the second story and attic two platforms 44 in. high are provided, reached by stairs. A portion of one stair railing appears in the right foreground of this picture.

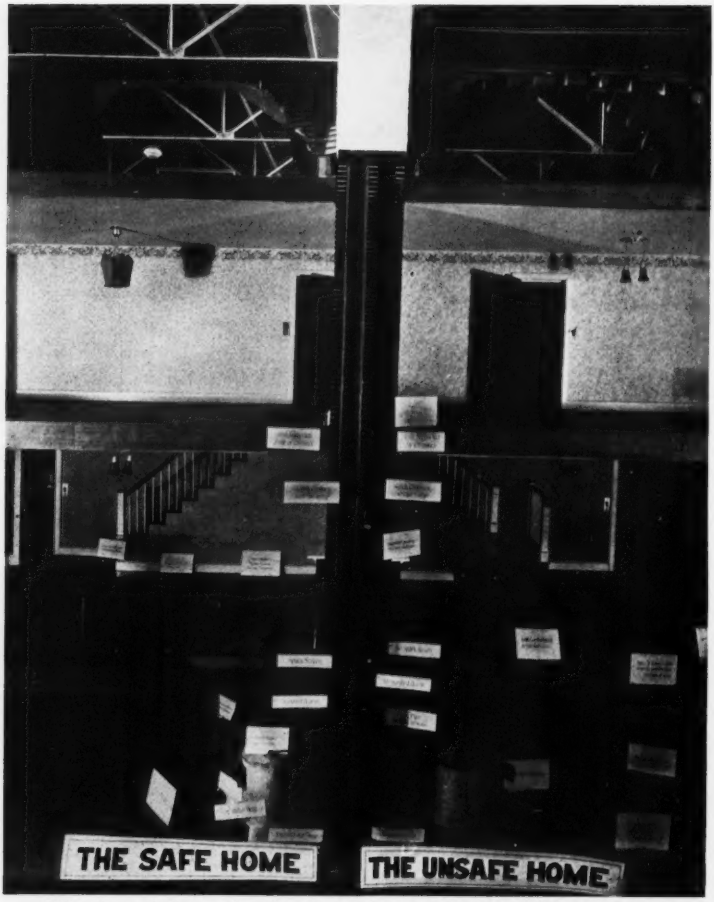
jacent partition safeguarded, the ashes are in wooden containers, there are rubbish accumulations in basement and attic, and no fire extinguishers, poor lighting invites the use of matches and candles in closets, matches are not properly cared for, neither are oils and other combustibles. These features and many others are taken care of in the proper manner in the standard house, and the lesson derived from the contrast is that one may



Floor plans of the "Home Safety" Exhibit model. The dimensions of the model are 13 ft. x 6 ft. 6 in., and 8 ft. 6 in. high, the whole model being constructed on the scale of approximately one quarter full size.

have a reasonably fire-safe home by the expenditure of no great amounts either of thought or money.

The accident features of the houses are equally interesting. In one, the bathroom lights are controlled by a switch at the door, in the other by key sockets; in one, access to the attic is easy and safe, in the other a movable ladder invites broken arms if not necks; in one, the stair rail extends to the last step, in the other the last two steps flare out beyond the newel-post inviting falls and stumbles; and so on. The sub-standard house has flower-pots on the window sill to fall on people's heads; there are boards lying about on the basement floor with projecting rusty nails to puncture the hide of the occupant who trips upon the tools left upon the lower stairs; the stair head-room is insufficient throughout the house inviting bumped heads; the basement stairs have no hand rail.



Side view of the model showing safe and unsafe conditions. The small signs on one side of the center fire wall call attention to hazardous features; on the other side corresponding conditions are as they should be, the signs so indicating each item.

Like most enterprises of an educational sort this exhibit has grown in interesting detail from week to week as those in charge have studied the "set-up" in the light of the comments and questions of people viewing the exhibit. There has been added a Gamewell fire alarm box with 6 in. gong located at a convenient height, so half-grown children can operate it. This was installed to educate the public in sending alarms to fire department headquarters. The standard house has also the fire department call-number over the telephone transmitter.

Fire Prevention Exhibit.

Canadian National Exposition.

The Fire Prevention Exhibit of the Ontario Fire Marshal Department (E. P. Heaton, Fire Marshal, G. F. Lewis, Deputy Fire Marshal, Members N.F.P.A.) attracted an exceptional amount of attention at the recent Canadian National Exposition in Toronto and was given the highest rating by the judges of the exhibits in the Ontario building. During the period of the exposition, August 28 to September 11, Deputy Fire Marshal Lewis reports that on several occasions it was necessary to discontinue the demonstrations in order to get the crowd to disperse.

The accompanying photograph contributed by Mr. Lewis gives a good idea of the arrangement of the exhibit. In the foreground at the left is equipment for demonstrating the lightning hazard. A large static machine capable of producing a spark a foot long is arranged with models to show the value of lightning protection and how fires are started and people killed by lightning. On the small platform there is a model farm with dwelling, barn, silo, windmill, etc. A telephone wire is arranged to illustrate how lightning may accumulate on wires and jump to buildings.

The Fire Prevention Exhibit and Demonstration Booth of the Ontario Fire Marshal Department at the Canadian National Exposition, Toronto, Aug. 28 to Sept. 11, 1926.

A tree to which a metal clothes line is attached and connected to the house shows how lightning may strike trees and be conducted to buildings. Sections of the metal fence are grounded and other parts left ungrounded to show how lightning can be taken care of and how it may cause loss of life to animals in the field. In front of the platform are samples of lightning rod material licensed for use in the Province of Ontario.

Further back at the left is a larger model of a barn equipped with proper lightning protection, also a spruce tree which is also protected by standard lightning rod equipment. Standing in front of the spruce tree is an electro-mechanical figure, representing a farmer, holding a banner reading, "Lightning is swift, but the cautious lead it in the rod." This farmer moves his eyes, lips and head in a most natural way.

Continuing to the right a panel showing fire alarm transmitting and recording apparatus is arranged for convenient inspection. On the wall behind this is a sign calling attention to Fire Prevention Week and announcing the presentation of 2,000 prizes for fire prevention essays in the public schools.

The large painting on the wall in the center background shows the Fireless Town and the Fire Waste Town.

Two self-operating continuous motion picture projectors showed various fire prevention films and pictures. Further along is a "Scene in Action," showing a factory on fire. Distributed at strategic locations are various exhibits and placards calling attention to the hazards of careless smoking, rubbish, etc. The further end of the exhibit, not clearly visible in this picture, is devoted to fire fighting equipment, including various types of extinguishers and a fire truck of the type used by community fire brigades.

The Drumcollogher Theatre Tragedy.

Some fifty people, men, women and children, were burned to death and a number of others injured in a motion picture theatre fire occurring in the village of Drumcollogher not far from Limerick, Ireland, on September 7. Every recognized safety precaution had apparently been ignored. A theatre had been improvised in the second floor of an old stable used as a garage. The hall was reached only by a narrow stairway so steep as to be called a ladder in the press reports. The windows in the hall were barred with iron rods. Nitro-cellulose films were left exposed on a table close to the exit. On the same table was a lighted candle. No fire protection of any kind was provided.

Some two hundred men, women and children were packed into the hall when fire started in the films on the table. Scenes of unspeakable horror followed. The following Associated Press report of the inquest after the tragedy gives the best available account of the details of the disaster:

"An old wooden building without any sort of fire apparatus, packed with men, women and children; an unprotected motion picture projector standing in the middle of a little hall, and flammable films lying on a table near it with a candle burning at the other end. This was the stage setting for the Drumcollogher movie disaster as described at the inquest today.

"William Ford, the owner, gave this testimony himself in relating the story of how some 50 persons were incinerated in Sunday night's tragedy and many others injured. Ford admitted he did not even have buckets of water or sand for protection against fire. Patrick Downing, the operator of the machine, told the coroner how two films on the table caught fire, and sobbed as he described the frightful stampede which followed. After telling how the two films blazed up, Downing said:

"I ran over and clapped my hands on them, but unfortunately some one came along and hit the burning films with a cap, and the flames went over on the other films. The crowd stayed still for awhile, as if expecting the fire would be put out, then they ran to the door. I shouted, 'Keep cool! Keep your seats!' but they rushed down to the door."

"At the height of the terror the flimsy ladder collapsed under the weight of those trying to descend, leaving many persons upstairs. The flames soon consumed the supports of the floor, which suddenly collapsed,

Wide World Photo.

Ruins of the improvised motion picture theatre in Drumcollogher, Ireland, where some fifty persons lost their lives. Charred bodies are piled behind the canvas screen in the background. The hall was on the second floor, reached only by a narrow steep stairway. Fire started in films on a table near the stairway. The windows were barred.

and all those remaining in the hall fell into the story below, where they were burned or crushed to death.

"Reports show that there was scarcely one conceivable element of horror lacking during the fire. A list of the victims is difficult to compile, owing to the almost complete incineration of most of the bodies. The charred remains were piled together behind a screen, guarded by police, awaiting the inquest. (See photograph.)

"One of the ghastliest episodes related at the inquest was the case of a woman whose feet became caught in the bars of a window, through which she was attempting to escape, and who was burned to death in that position. John Davis, a civic guard, describing the tragedy, said:

"About 50 or 60 people were huddled in a corner. I called on them to follow me. I caught two girls and started to rush them to the entrance door. I heard some one shout: 'Come back!' and the girls tore away from me and ran back. One of them ran toward a little dressing room and tried to get out by the window. I followed her and started to run with her again toward the entrance door. Four or five fellows, rushing across the hall, knocked us down. I looked up the hall and saw that the front of the place near the entrance was all ablaze. The spectators were huddled in a mass at my end clinging together in death-like grips, with horror and dread in their faces. Shouting for them to follow, I started to run, dashing through the flames, and flung myself down the burning stairway. Unfortunately, they did not move and all perished."

Tanker Fires.

By A. J. Smith,
Secretary, Marine Committee, N.F.P.A.

The long list of disastrous fires and explosions on oil tank vessels has drawn the attention and best efforts of operators, designers, builders and fire prevention experts toward at least elimination of preventable hazards. The necessarily general rules of such organizations as the National Fire Protection Association have been supplemented by many of the operating companies by their own rules, usually much more drastic and specific than the general regulations.

The knowledge of the hazards based on bitter experience and the enforcement of precautionary rules has doubtless greatly reduced the number of tanker accidents under what might have been; but in spite of all this the record is far from clear of accidents.

Three outstanding tanker fires and explosions are recorded in the disaster roll of 1926: the collision between the Dutch tank steamer *Silvanus* and the American tank steamer *Thomas H. Wheeler* resulting in fire; the fire and explosion on the American tank steamer *O. T. Waring* and the explosion and fire on the American tank motor ship *Gulf of Venezuela.*

The "Thomas H. Wheeler" and "Silvanus" Disaster.

On April 8, 1926, about 8:30 P. M., the Standard Oil tanker *Thomas H. Wheeler* and the Dutch tanker *Silvanus* collided in the Mississippi River near Favret light about forty miles below New Orleans.

The investigation conducted by the U. S. Steamboat Inspection Service found that a light fog lay over the east bank of the river and extended out into the stream in this vicinity. The fog was low lying, but high enough to conceal the hulls of the vessels and the side lights were not visible to each other until the collision was inevitable. However, the masthead lights were always visible to each other above the bank of fog.

The *Wheeler* was inbound coming up the river keeping close to the east bank. The *Silvanus* was outbound and presumably keeping to the middle of the river to take advantage of the current. Both vessels were blowing fog signals.

About ten minutes before the collision, the pilot on the *Wheeler* deemed it advisable to pull in toward the bank and anchor by Favret Light. The engines were stopped and preparations made to anchor.

According to the testimony of the master and pilot of the *Wheeler,* the *Silvanus* loomed up through the fog dead ahead and coming at full speed. The pilot on the *Wheeler* ordered full speed astern and the ships

apparently exchanged signals to pass port to port. It was apparently the intention of the pilot of the *Silvanus* to endeavor to avoid collision by throwing his bow hard to starboard and by going full speed ahead to drive the steamer clear of the *Wheeler,* and the pilot of the latter cooperated by driving his steamer full astern. However, they came together; the port side of the *Silvanus* about abreast the bridge crashing on the bow of the *Wheeler.*

From the testimony of the personnel of both vessels, the impact was followed by a blinding flash, both were enveloped in flames and soon the water all around was ablaze with floating fire.

The *Silvanus* had a full cargo of benzine which flowed out when the shell plating was broached by the collision and it is believed some sparks were generated thereby which ignited the benzine. This vessel became a total loss. Immediately after the collision, the *Wheeler* at full speed pulled out of the zone of fire on the water and coming to anchor, the whole crew fought the fire on board until it was extinguished.

Twenty-five of the crew of the *Silvanus* lost their lives, but fortunately there was no loss of life on the *Wheeler.* It is remarkable that both were not totally destroyed.

The "O. T. Waring" Fire

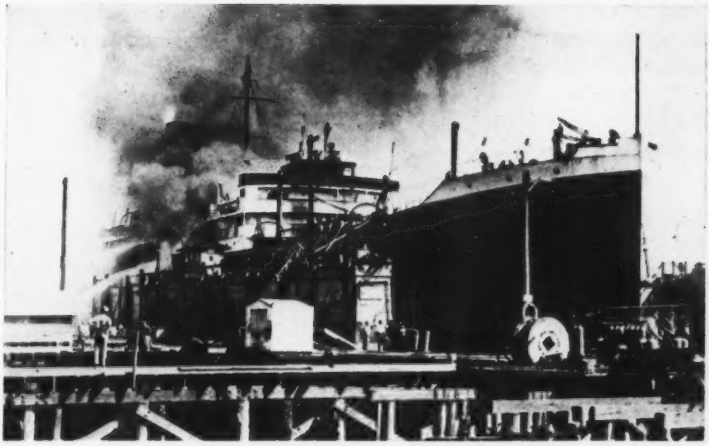
The disaster on the *O. T. Waring,* a tank steamer owned by the Standard Oil Co., occurred on the same day as the collision between the *Silvanus* and the *Wheeler,* April 8, 1926, while lying on the floating drydock at Jahncke's yard, New Orleans.

The vessel had delivered a main cargo of gasoline with some distillate and lubricating oil from the cofferdams and deep tank at Tampa, Florida, and was proceeding in ballast toward Baton Rouge; but at noon on the 7th, was diverted by wireless order from the company to drydock at New Orleans for general overhaul.

Tank steaming was started immediately on receipt of this order and the vessel proceeded up the Mississippi and to anchor off Jahncke's Drydock, arriving early the morning of the 8th.

When the yard opened for work, a labor gang was sent off to the vessel to rig hose and start washing down tanks and a machinist gang to start stripping down in the engine room. The washing started as soon as the vessel was set in the dock and continued after it came dry, about 11:00 A. M., until all tanks except two of the cofferdams which still contained much oil or gasoline were finished and windsails rigged. The washing was done from deck through the hatches and it was impossible to reach the upper parts of the tanks in the wings of the vessel.

In the meantime, work in the engine room and pump room was proceeding, several boilermakers were removing the bleeder plugs from the



International.

Tanker "O. T. Waring" of the Standard Oil Co. on fire in drydock in New Orleans following the explosion which killed eight men.

bottom of the vessel to drain tanks, a machinist gang had started to remove the propeller and a gang of laborers had started to clean ship's bottom.

No chemist boarded the vessel to test tanks for gas content and none of the ship's officers knew whether or not such a test was intended; their lack of knowledge being claimed due to the fact that the ship was in the hands of the shore superintendent and/or the dry dock. It is certain that up to the time of the fire no test had been made and it appears, from testimony at the subsequent hearing before the U. S. Inspectors, equally clear that the tanks were still very gassy during and after the washdown. Much gasoline was mixed with the flow onto the dock from the bleeders, No. 2 cofferdam between No. 6 and No. 7 tanks was deep with gasoline and No. 3 cofferdam contained so much oil or oil and gas mixed that it was replugged after the bleeder had been opened; in fact a special watch was detailed by the yard presumably on account of the foul condition of the vessel and dock. Doubtless a test and gas-free certificate was intended as preparations were under way to redrive some bottom rivets, but no burners or hull mechanics had yet come on the dock at the time of the fire.

About three hours after the vessel came dry or about 2:15 P. M., a flash of flame burst out on the starboard side of the vessel abreast No. 6 and No. 7 tanks, apparently from between the ship and the wing of the dock. It spread to the port side and blew aft and over the deck for about a minute as described in the majority of testimony. Then a series of several explosions followed at close intervals.

The vessel was badly wrecked amidships and aft, eight men were

killed or were missing and about forty more or less injured, some by flame or explosion and others by sliding down lines hanging from the port quarter and dropping to the floor of the dock.

A definite cause of the fire has not been ascertained, but it appears likely that the fumes from gasoline flowing onto the dock somewhere came in contact with spark or flame as the testimony is practically agreed that the fire seemed to come from between the vessel and the dock wing or from under the starboard side. It was also brought out that there had been some trouble between the crew and yard men about smoking on board by the latter. The fire also spread aft on the drydock and water and set fire to the river steamer *City of Pittsburg*, which was lying moored just astern of the drydock on which the *Waring* was hauled.

The "Gulf of Venezuela" Explosion.

The explosion on the tank motor vessel *Gulf of Venezuela*, belonging to the Gulf Refining Co., occurred at Port Arthur, Texas, on April 11, 1926, while at the loading berth of the owners taking on a cargo of gasoline. Loading through the pipe lines and connected hose had commenced early in the evening and continued during the night. The watch officer, a quartermaster and an able seaman had charge of the tanks and connections on board and a pier superintendent and assistants were watching the valves and lines on shore. Most of the crew had turned in.

At about 2:30 A. M. the last tank was being filled. The vessel was expected to sail at five. The engine watch was below and had just started the Diesel-driven generator which supplied current for the ship's electric motor-driven auxiliaries, among them the circulating pumps which were running preparatory to starting the main engine. The oil burning donkey boiler also had one fire going.

The sight holes were open on several of the tank hatches, including the one being filled, No. 9 aft; and the doors to the crew quarters alleyways in the poop were also open.

At this time the deck officer on watch went to his room to get another flashlight, the one he had been using being low. He left instructions with the quartermaster to call him if the oil in No. 9 reached the bottom of the expansion trunk before he returned.

After renewing his flashlight battery he made entry of some scratch memoranda regarding previously filled tanks, and just as he finished the pier superintendent opened his door and shouted that the tank trunk was overflowing. They both rushed to the dock valves and shut off the filling line, but not until a large quantity of gasoline had flowed over the after deck. As the mate turned to go back on board he noticed the quartermaster writhing on the deck as though gassed; but before he could reach him the explosion occurred, wrecking the poop and crew

International.

Tank motor vessel "Gulf of Venezuela" following the explosion and fire at Port Arthur, Texas.

quarters aft and spreading fire over the whole after end of the vessel.

Almost everyone aft was more or less burned or injured and several lost their lives, among them the quartermaster and seaman on watch.

The fire was eventually extinguished by shore apparatus after members of the crew had gone on board under a water curtain and shut the open sight hatches. Foam is said to have been the principal extinguishing agent.

The men in best position to know the cause of the overflow and consequent disaster were killed; but apparently the amount of slack in the tank at the time the mate left to change his light was misjudged and the quartermaster watching too closely became gassed and could not give the standby signal. Several possible causes of ignition were brought out at the hearing before the U. S. Inspectors. A traveling yard crane was working on the shore not far distant, but the wind was in a direction which would not have carried the fumes to it and the possibility of its being the cause is remote. The Diesel engines on this vessel had been giving trouble by sparking up the exhaust and it was testified by some that sparks were coming from the funnel exhaust just prior to the overflow. This is a possible cause. The most likely, however, in our opinion is that the fumes from the overflow spread into the poop alleys and there were ignited by the donkey fire or galley range, causing the explosion which wrecked that part of the vessel.

The first of these disasters seems to have been one of those cases where only entire avoidance would have been of avail and that it was pure accident with little or no fault involved. The two latter do not bear the same coat of whitewash; as carelessness, negligence or stretching a chance were obvious contributory causes. The price is far too high to pay for a warning; but paid, let it serve.

Fire Stream Capabilities of Water Mains.

By Fred. Shepperd.

Managing Editor, "Fire Engineering."

When it is said that a 4-inch main can supply but a single fire stream, pressures are assumed to be within the ordinary range of such as found in present day water systems.

But, theoretically, there is no limit to the number of fire streams that could be supplied by such a main. It is but a question of pressure. If, for instance, a pressure of 1,000 lbs. could be maintained on a 4-inch main the discharge would be increased proportionately through that main. Instead of supplying but one fire stream it might be capable under these conditions to supply as many as ten such streams.

At higher pressures, the discharge would be still further increased and the number of streams supplied increased in proportion.

But water mains and water pumping machinery are not built to stand or produce unlimited pressures nor is fire hose capable of standing pressures above those at which the hose can readily be handled by firemen without special appliances.

It is these limitations—strength of mains, capabilities of pumps, strength of hose, and safety in handling hose lines which limit the capability of 4-inch and other size pipes.

The factors which enter into the number of streams that mains of various sizes will supply include the following:

Diameter of pipe.
Age of pipe.
Length of pipe line.
Diameter and length of feeder lines.
Pressure at source of supply.

Other factors enter into consideration such as grades along which the mains are laid and also the number and type of fittings such as valves, etc., in pipe lines. These two latter, however, will not be taken into consideration here.

The various factors will be treated separately.

DIAMETER. Quantity of water which can be supplied by mains increases tremendously with the increase of diameter. A 4-inch main, for instance, supplies less than one quarter of what an 8-inch main would supply.

This paper was delivered before the convention of the Dominion Association of Fire Chiefs, Windsor, Ontario, August 24-27, 1926.

AGE. Age greatly affects the capacities of mains particularly where incrustations or sediment is apt to form. The older the main the larger the amount of incrustations and the greater the consequent reduction in flow area.

LENGTH. Length of main to point of supply is another important factor in determining the capabilities of a system. Friction loss in water mains varies directly as the length and the longer the distance water must flow from the source of supply to the point at which it is being taken from the main the greater will be the drop in pressure due to friction. That is why, in the table shown later, the number of streams which a main can supply decreases as the length of the main increases.

DIAMETER AND LENGTH OF FEEDER LINES. Where a pipe line is supplied by a single supply main, the diameter and length of the supply main enter into the problem very definitely. Suppose a 6-inch pipe line 1,000 feet long is being supplied by an 8-inch main which, upon investigation, is found to be 2,000 feet to the source of supply, without cross connections. This great length of the 8-inch main will have marked effect in reducing the pressure in the 6-inch main as soon as flow starts due to the friction loss in the 2,000 feet. The length of the feeder mains must be taken into account, as well as their diameters in determining the performance of any particular main in the system.

PRESSURE. The subject of pressure in fire streams is quite well understood by those engaged in the fire service and all that need be said here regarding pressures in water mains is that such pressures have the same effect in water mains as in fire hose: the higher the pressure the greater the discharge from a main; the higher the pressure the longer the line of pipe that water can be forced through.

What Happens When Excess Capacity Is Required of a Main.

When an attempt is made to take more water from a main than it will normally supply, under a given pressure, the pressure may drop until it falls below zero—that is, becomes a vacuum. If a vacuum is pronounced, trouble may be expected in the pumping engine or in the fire stream delivered by it.

If there is a vacuum at the suction side, or intake of the pump, it requires only a loose connection anywhere within the pump to cause air leakage. Air leakage means broken streams, for air which enters the pump is compressed and upon leaving the nozzle under pressure it expands and breaks the stream up, reducing range and effectiveness. Where the pressure at the source of supply to the main is constant there is a limit to the amount of water which can be taken from the main. Once a vacuum is created at suction of a fire engine taking water from the main, the limit may be considered to have been exceeded.

Water Pressures on Mains.

In the figures given in the table below an average pressure of 45 pounds will be assumed in the main. At this point it might be well to classify various pressures as found in water works.

Low pressure—below 45 pounds—sufficient for fire engine or pump supply but inadequate for other service except to a very limited extent in very low buildings.

Medium pressure—45 to 70 pounds—sufficient for moderate streams for inside work for buildings up to three or four stories with moderate lengths of hose.

High pressure—70 to 100 pounds—very effective stream through hose lengths up to 300 feet giving excellent auxiliary service to fire department.

In assuming a pressure of 45 pounds the author has in mind the average small city water works system. This pressure will be employed throughout the calculations in the table given later on.

Fire Streams Supplied by Various Size Mains.

In the following table an average pressure of 45 pounds on the system will be assumed as previously noted.

Pipe will be assumed with an average age of four years.

Diameter of Pipe	Length of Main Dead Ended (or fed only from one end).	No. of 250 G.P.M. Streams taken from Fire Engine.	Length of Main Between Cross Connections (fed from both ends).	No. of 250 G.P.M. Streams taken from Engine.
4 inch	500	2	500	3
4 "	1000	1	1000	2
4 "	1500	0	1500	1
4 "	2000	0	2000	1
6 "	500	5	500	7
6 "	1000	4	1000	5
6 "	1500	3	1500	4
6 "	2000	2	2000	4
6 "	2500	1	2500	3
6 "	3000	1	3000	3
8 "	1000	8	1000	11
8 "	1500	6	1500	10
8 "	2000	5	2000	8
8 "	2500	5	2500	7
8 "	3000	4	3000	6
8 "	3500	4	3500	5
8 "	4000	3	4000	5

Only 4, 6 and 8-inch mains are listed, for a 10-inch main gives far more streams than are usually required at an average fire in a small city or town such as this paper is intended for.

For example, a 10-inch main of around 1,000 feet in length may give around 14 fire streams—more than the equipment of a small city fire department is usually capable of handling.

By an average fire stream we refer to a stream produced by a 1⅛-inch nozzle and a nozzle pressure of 45 pounds. Such a stream has a discharge of 250 gallons per minute and a vertical reach of 70 feet with a horizontal reach of 67 feet.

In making up this table a residual pressure of between five and ten pounds is allowed at the hydrant. In other words when considering friction loss of a system a friction loss of between five and ten pounds less than the supply pressure in the main is permitted, a hydrant being capable of discharging the flow required for two streams at residual pressures of from five to ten pounds.

Testing Your Water Supply.

While the preceding figures give the capabilities of various size mains theoretically, local conditions may change this entirely and it is therefore most desirable that tests be conducted to determine just how much water can be expected from one or more hydrants on a main or in a particular district.

As an example of what might occur, a fire over in a Jersey town near New York City is cited. A pumper was operating at the end of a long line of 6-inch pipe. It was getting a satisfactory supply and delivering two good streams. After operating a little while a second pumper pulled in and was hooked to the 6-inch main from which this first 6-inch main was receiving its water. The second engine so reduced the pressure in the supply main that the pressure remaining was not sufficient to satisfactorily supply the first engine, with the result that a pronounced vacuum was indicated on the first pumper. While the second engine did not actually connect to a hydrant on the main on which the first engine was operating, it did connect to the 6-inch main supplying the 6-inch pipe. This instance is merely given to indicate that there are more factors entering into problems in connection with water supply systems than are generally assumed.

The method of determining the flow from hydrants is not at all complicated and all that is required is proper gauge equipment.

Testing of hydrants and mains connected thereto frequently results in some unforeseen good. Opening a hydrant to test its discharge might result in finding closed valves on a line, serious incrustations, or might even result in flushing out of the main and increasing its capacity. There

is nothing like knowing precisely what any main in the system can give, or what any particular hydrant is capable of doing both in the way of discharge and pressure.

Discussions arise between fire and water departments of a city as a result of unsatisfactory pressure at fires—the water department is frequently in a position to show that the pressure at all times in the system is satisfactory. But there is a great deal of difference between the static pressure, or pressure in the mains when the water is at rest, and the flowing pressure.

Static pressure means little. Small pipe systems, badly corroded pipes, or long dead end runs of fair size pipe, of apparent value are at once shown deficient by a flowing test from an open hydrant butt. In one instance, an important car barn depended for hose protection on a city connection carrying a 70-pound static pressure. Under open butt test, a gauge graduated by pounds would not register. In the case of a pretentious country estate, a 140-pound static pressure dropped to ten pounds, when 270 gallons per minute were taken from the end hydrant on the system.

As to the exact methods of conducting flow tests of water systems, any of the many handbooks on fire protection—either industrial or municipal—may be referred to. Practically all of these books give detailed methods of conducting the tests to determine hydrant and main discharge and it would be a waste of time to enter a detailed discussion of it here.

(In this connection the article by Geo. W. Booth on "Flow Tests of Water Supplies," in the January, 1925, QUARTERLY, Vol. 18, No. 3, p. 236, will be interesting.—ED.)

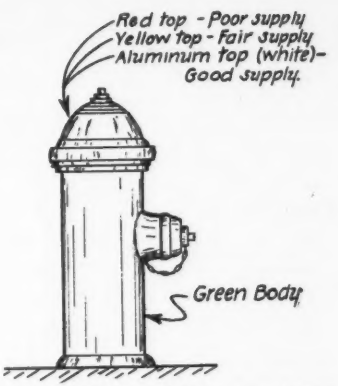
Marking Fire Hydrants.

It is a mighty fine practice to mark hydrants after their capabilities are determined in such a way that fire companies responding to an alarm will know just what they can expect from any particular hydrant.

Some cities have three classifications into which they group their hydrants, namely, good, fair and poor. Those in the classification "good" would be the ones which could supply one or two fire engines; those in the classification "fair," would be the ones which could supply a single pumper or one hydrant stream; those in the classification "poor" would be the ones which could not be depended upon for either a good engine or hydrant stream supply.

A practice which is in vogue in many fire departments is to paint the barrel of the hydrant green or red. The hood or top of the hydrant is then painted a distinctive color such as aluminum, yellow, or red. An aluminum top might indicate good supply, a yellow top fair supply and a red top poor supply.

New York City, on the other hand, has a method of its own in marking hydrants. The hydrant is marked on the barrel with the size of the main to which it is attached. In other words there is a large number painted on the barrel where it is conspicuous, such number being the diameter of the main to which the hydrant is attached.



Suggested method of painting hydrants, color indicating character of supply.

Knowing Water Main Layout.

Knowledge of the water system, sizes and lengths of mains and the location of hydrants will be the means of eliminating delays and mistakes of departments in operating at fires.

Knowing that a certain section of the city, for instance, is supplied by a single 6-inch main will at once tell what will be needed in the way of apparatus to get water from mains having an adequate supply. One of the most effective means of familiarizing firemen with the water system is to place in each fire station a black and white print of the portion of the city which the company in that station covers showing the sizes of mains and the location of hydrants.

The men can mark on the map the classification of the hydrants—having the map marked to tally with the painting on the hydrants. For example, if an aluminum top hydrant indicates a good supply, then on those hydrants connected to large size mains, aluminum markings might be made. Likewise with the hydrants shown on the map having a fair water supply and a poor water supply the corresponding marks might be made.

The serious mistake of expecting too much of small size mains will be avoided by this practice.

Three Illuminating Gas Explosions.

Gas explosions in dwellings are of infrequent occurrence, in view of the very widespread use of gas for house lighting, cooking and heating. Only about one per cent of the fire loss in dwellings is attributed to gas, natural and artificial. This is a low figure in the light of the character of the hazard and the almost universal use of gas wherever available. When gas explosions do occur, however, the results are apt to be serious.

One of the three explosions reported here was followed by fire; the other two demolished the buildings but no fire followed. In two of the three cases escaping gas was ignited by the pilot flame of a gas stove or water heater.

St. Paul Explosion.

Report by John Townsend, Jr.

Superintendent, St. Paul Fire Insurance Patrol (Member N.F.P.A.).

A gas explosion wrecked the residence of Dr. K. C. Wold, St. Paul, on August 25, 1926. The house was a brick and stucco 2½-story building, the upper part of the house being stucco and the lower part brick veneer.

Dr. Wold had complained of leaking gas for the past three days and the Northern States Power Company, which has charge of the gas supply in the city, was endeavoring to locate the leak. The company had sunk several holes along the street about a block away from Dr. Wold's house but had not been able to discover the leak. The smell of gas did not grow very much stronger until the afternoon of the explosion. About 4:00 o'clock the gas was so strong in the house that Mrs. Wold took the four small children out on the front porch and at about a quarter to five becoming alarmed at the still stronger odor of gas she took them all to a neighbor's house.

At about 5:00 o'clock there was a terrific explosion and a great sheet of flame swept through the house and seared the grass on the front lawn for a distance of twenty-five feet, and seemed to ignite the ground in the street where the men had been digging to discover the leak. This flame from the ground burned for about five minutes and then went out. The force of the explosion tore the front porch off, blew out all the windows on the first floor and knocked all the brick veneer off the house. The damage by fire was very great on the inside of the house. I arrived there about fifteen minutes after the explosion and it looked to me as if

Underwood and Underwood.

St. Paul residence wrecked by gas explosion and ensuing fire. Gas seeped into the building from a leaking gas main and was ignited by the pilot light of a gas stove.

the fire had been burning for hours inside the house. The fire was practically under control by this time but the stairs were burned through, the woodwork was badly charred, the plaster and laths were burned through in places, and the furniture throughout the house was practically destroyed. There was a brick house on the east side of Dr. Wold's house which was scorched by the flames, but the force of the explosion was expended through the other side of the house which fronted on the street and had been built with quite a few windows.

There has been no official statement made by the Northern States Power Company as to the exact cause of the explosion, but upon investigation by the fire marshal's office the facts have been ascertained. A main gas feed line ran by Dr. Wold's house about twenty feet distant. A hole about three quarters of an inch in diameter was found in this pipe not far from the gas line leading into Dr. Wold's house. The soil in this district is loose sand and gravel and it is thought that the gas escaping from this hole in the main feed line followed the line of least resistance along the gas pipe leading into the house, gradually filled the basement and worked its way through the house. When this mixture of gas and air reached the right proportion it was probably ignited by the gas pilot light of the hot water heater or gas stove. There probably also was some leakage from the main feed line up through the gravel soil to the surface

of the street which accounted for the flame burning in the street.

Dr. Wold only carried $15,000 insurance on the house and $2,000 on the contents. The house is valued at $28,000 and the contents at about $10,000. Whether or not Dr. Wold will be able to collect damages from the Northern States Power Company will be a question for the courts to decide. The house is totally wrecked and will have to be torn down as the foundation, which was of concrete blocks, was badly damaged. The contents also were totally destroyed. It was very fortunate that Mrs. Wold took the children out of the house when she did, otherwise they would all have been killed. The interesting point of this explosion was the evidence of such a great amount of heat caused by the explosion of the gas.

El Monte, California, Explosion.

Report by Fireman's Fund Insurance Co.

(Member N.F.P.A.)

The terrific power of ordinary illuminating and cooking gas is well illustrated by the wrecked residence shown in the accompanying photograph.

This dwelling, located near El Monte, Calif., was blown up on March 27, 1924, by ordinary gas which leaked out of the governor or reducing gauge on the gas meter. The leak allowed the full force of the gas from the main, under 60 to 80 pounds pressure, to escape. The hissing noise caused by the escaping gas awakened the family at 4:30 in the morning.

Courtesy Fireman's Fund Record.

Ruins of a home in El Monte, California, destroyed by a gas explosion. The occupants, warned by escaping gas from a high pressure main, fortunately had left the house when the explosion occurred. Despite the combustible character of the construction there was no ensuing fire in this case.

Keystone.

The owner of this Canton, Ohio, home, wrecked by a gas explosion, was blown through the wall of the house and according to newspaper reports was found unconscious on the driveway, but escaped serious injury.

The owner of the house realized the danger immediately and warned his wife and daughter not to strike any matches and to get out of the house as soon as possible while he went next door to call up the gas company.

Fortunately everyone was outside when the accumulated gas came in contact with the pilot light on a gas heater and set off the explosion. The force of the explosion broke a number of windows in the neighborhood.

Canton, Ohio, Explosion.

Report by R. A. Myers.

Ohio Inspection Bureau (Member N.F.P.A.).

A gas explosion, the results of which are shown by the accompanying illustration, wrecked the home of Mr. Ralph Lappin, Maryland Ave., Canton, Ohio, on May 26, 1926. No fire followed the explosion. First reports indicated that Mr. Lappin was thrown through the wall of the house and picked up unconscious on the driveway and that two other members of the family were injured. Subsequent investigation failed to disclose personal injuries of any consequence. The following account of the circumstances of this explosion has been furnished by the gas company:

"Maryland Avenue was being graded preparatory to paving and other public improvements, the street being widened from three to four

feet on the west side. Sometime during the day of May 26, 1926, a steam shovel was working in this vicinity and evidently came in contact with the service pipe, bending it. A street ell located at a point about 18 in. from the basement wall was broken in two. Our investigators state that it was apparent that a considerable amount of gas escaped into the basement, working up between the walls of the frame dwelling. Undoubtedly, the gas became ignited from the fire in the furnace, causing the explosion referred to."

It is reported that the gas company completely rebuilt the house for the owner.

Liability for Forest Fires in Pennsylvania.

By George H. Wirt.

Chief Forest Fire Warden, Pennsylvania.

The Pennsylvania Forest Service, a division of the Department of Forests and Waters, recently collected the cost of extinguishing a forest fire in Blair County, Pennsylvania, from the persons responsible for it. This follows the general policy which has been in effect since 1916.

In this case we received information to the effect that John Royer and James McConnell were burning brush on April 20, 1926, in Logan and Tyrone Townships, Blair County, and thus started a forest fire that burned over about 800 acres of land and cost the Commonwealth $649.52 to extinguish.

Royer and McConnell were taken before a Justice of the Peace in Duncansville, Pa., pleading guilty, and were held under bail of $500 for appearance at the June term of Court. There was no question of their guilt. Both wished to do the thing which would be the best for them and so asked to settle the cost of extinguishing of $649.52. The district forester and the attorney for the Department of Forests and Waters discussed the case with Royer and McConnell and arranged a settlement in which both Royer and McConnell signed a judgment note for the $649.52. Upon obtaining the first payment and the note, an interview was had with the district attorney of Blair County in which he agreed, upon our request, to drop the criminal charges against both Royer and McConnell. They also will pay the cost of prosecution up to the time of dropping the charges.

It has been our policy since 1916 to submit to every person or corporation upon whom we can place reasonable responsibility for a forest fire a bill for the cost of extinguishing the fire and in case the fire has

burned over a State Forest we have sent a bill covering damage done to State-owned forests.

We have done this in spite of the fact that there is no specific law in Pennsylvania authorizing us to do it. We believe, however, that such a policy is right and fair and consistent with existing general laws and policies. Practically all of the railroad companies operating in the state have accepted the policy as a satisfactory one and have reimbursed the Commonwealth for the cost of extinguishment in the case of fires where there was no question of responsibility. A great many individuals and corporations other than railroads have paid these bills as a fair business proposition.

We have never started a civil suit in any of our courts to determine the exact legal status of such a policy although we have had several attorneys who have stated that they could institute such proceedings for us and that in their opinion these would be successful. On the other hand, in the case of the number of criminal actions which we have brought when the defendants have been found guilty of violating the forest fire law, the Courts have exercised considerable discretion in placing penalty upon the defendant and have instructed that the cost of extinguishment be paid to the Commonwealth just as the cost of suit be paid to the County.

We believe that with the exception of fires which come from lightning all other forest fires are the result of someone's carelessness and that the party responsible for the fire should reimburse the Commonwealth for cost of extinguishment. This is exactly in line with legislation now in existence in a number of states which makes the individual who has been careless with fire in buildings reimburse the city or town for the expense incurred by a fire department in extinguishing the fire for which the careless one was responsible.

Installation of Domestic Oil Burners.

By E. J. Smith (Member N.F.P.A.)

Engineer, Underwriters' Laboratories.

The proper installation of a domestic oil burner is vitally important and so many questions have been raised with regard to interpretation of the Regulations of the National Board of Fire Underwriters for the Installation of Domestic Oil Burning Equipments as recommended by the National Fire Protection Association—1925 Edition, that the writer is attempting briefly to give his own answers to some of the points in question and to give an outline of what to do and what not to do when making an oil burner installation.

No doubt we all agree, in a measure at least, with the preface which states that the safest type of oil burning system for domestic use is one in which all piping and the tops of the tanks connected therewith are located below the level of the base of the burner, but when we continue and say that this ideal oil burning system is one in which the supply of oil to the burner is so controlled that there may be no reason to expect the possibility of a continuous discharge of oil into the building in case of pipe breakage or ignition failure, we find ready room for argument. Some will say if the tank is located with its top below the level of the burner and if we use a burner equipped with a pump which discharges fuel only when there is a demand for heat, we have the ideal installation. Perhaps they are right, but since we know that in order to secure necessary flexibility of operation we must have an excess pump capacity, there is always a greater or less amount of oil being circulated in the system while the burner is in operation and this oil is just as ready to escape in case of pipe breakage as is the oil in a gravity system or in a pressure system. It is hard to understand wherein greater immunity from breakage may be assumed for the return line of a pump system than for the supply line of a gravity system, but such must be the case if we are to say that the pump equipped burner is, without any qualification, safer than a gravity feed system.

It is undoubtedly true that a gravity feed system may be so installed as to be safer than a pump type system, but let us hasten to say that the reverse may be just as true. In other words, there may not be that vast difference between a gravity feed system and other types of oil feed as some would lead us to believe. Frankly, in the writer's opinion, the principal concern is not the type of oil feed but the principles involved in the con-

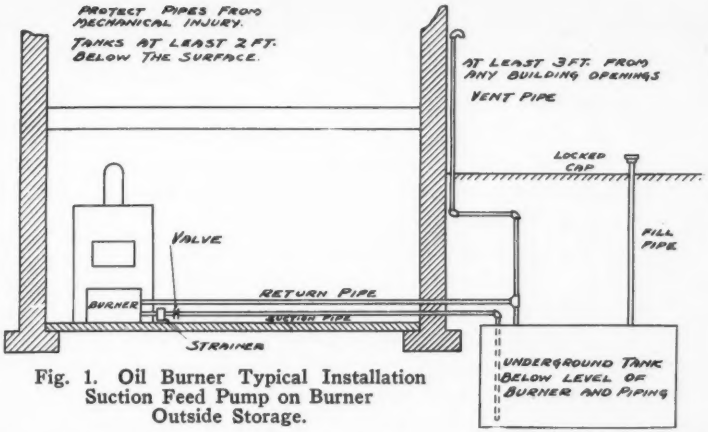


Fig. 1. Oil Burner Typical Installation Suction Feed Pump on Burner Outside Storage.

struction of the oil burner and the thoroughness with which the installation regulations are complied with. It is not intended at this time to discuss the various features of standard types of burners, but it may not be amiss to point out that the more or less common practice of distinguishing between the two general types of domestic oil burners by the use of the terms "power burners" and "gravity burners," is very misleading. Oil may be supplied to either type by gravity or power and for this reason why not designate the one that requires no mechanical means for creating a draft, a natural draft burner, and its contemporary, a mechanical draft burner?

It is difficult in a short article such as this to cover all possible phases of domestic oil burning installations. For this reason illustrations Figs. 1, 2 and 3 will show typical features of only three of the most common forms of installations. Fig. 1 shows the proper relation of the various parts in the installation of a standard oil burner of a type in which the pump is an integral part of the burner. Fig. 2 indicates a common form of installation with a burner of the type in which the oil is supplied by gravity to the burner. Fig. 3 is similar to Fig. 2 but in place of the familiar 60 gallon gravity tank we have a standard type of automatic power pump. Numerous modifications of these typical installations are being made and likewise other methods of transferring fuel from supply tanks to oil burners are frequently encountered.

One of the most frequent questions relates to what may be done properly to safeguard an installation, where, on account of local conditions, it is impossible or impractical to install the outside storage tank so that its top will be below the level of the lowest pipe in the building. It will be obvious by reference to either Figs. 1, 2, or 3, that if the underground

storage tank is installed at a point higher than the various pipes leading into the building, we will have a condition where, in the case of breakage of the pipe at a low point, there will be a possibility of the entire contents being discharged into the building by siphoning. Rule 1 (a)[1] on the location of storage tanks states that in such cases adequate provisions to prevent siphoning shall be provided, and in a note makes a general reference to some methods that have been employed and that have been accepted in some territories.

The question is frequently asked whether the suggested methods are adequate for all conditions, and whether any one of the methods briefly described will be accepted in all territories. It is to be noted that the note merely states that certain methods may be acceptable, and furthermore points out that such acceptance is dependent upon the specific approval of the inspection department having jurisdiction. As a matter of fact, the methods described in the note are not intended to be other than suggestions, and were placed in the rules at a time when the so-called anti-siphoning devices were not so well known as at present. There are at present devices on the market, some of them listed by Underwriters' Laboratories, which are far superior to probably most of the expedients in the note mentioned.

The note suggests the use of a fusible plug located at the top-most point of the pipe lines, the purpose of which is to melt in the case of a fire, and thus allow the oil in the pipes to drain back to the underground storage tank. This arrangement undoubtedly has some value, but naturally, if the breakage has occurred before the fire, the contents of the tank may be drained into the building before the fusible plug has melted. Weighted foot valves likewise will serve to prevent siphoning, but in case of leakage of the valve through an imperfect seat on account of foreign material lodged on the seat, they would, in such cases, only be partially effective in case of breakage of the pipe. Enlarged pipe sections[2] on the discharge side of the siphon will, if properly proportioned with respect to the height of the tank above the burner and the capacity of the burner pump, effectually prevent siphoning, but since this arrangement to be

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[1]Rule 1 (a), Regulations for Domestic Oil Burning Equipments, reads as follows:

(a) Storage tanks shall preferably be located outside, underground, with top of tank below the level of the burner. Where conditions are such that top of tank is above the burner, adequate provisions to prevent siphoning shall be provided.

NOTE: For small installation where pipe lines are 1-inch or less, provisions which will break the siphon at time of fire, such as an air inlet held closed with fusible metal located at top of bend, may be acceptable. Weighted foot valves; enlarged pipe section on discharge side of siphon; or air inlets at top bends controlled by pump pressure, are provisions which may be acceptable in any size piping, depending upon the elevation of the tank, and upon specific approval of the inspection department having jurisdiction.

[2]For description of this type of anti-siphoning arrangement see QUARTERLY, Vol. 19, No. 1, p. 78.

effective must be properly proportioned to fit the case, it is obvious that the only way in which its effectiveness may be determined will be to conduct a suitable test on each and every installation, as made.

Air inlets at the top of vents controlled by pump pressure also have been used, but many of these are more or less delicate, and likewise may be open to the criticism that their use may make it difficult to pick up the suction when the oil burner pump is not of sufficient capacity promptly to supply oil when first starting. It is also to be noted that even though arrangements are made to prevent siphoning through the suction line, in case of breakage, many of the expedients followed will not in any manner prevent the continuous discharge of oil from the return line in case of its breakage, and accordingly, the only safeguard against the discharge of oil lies in the strength of the pipe, which normally is one size larger than the suction line. Of course increasing the size of this pipe will reduce the possibility of breakage, but nevertheless, as there are at present devices on the market designed to be installed in the suction and return line at a point above the level of the top of the tank, and which in case of breakage of either of the pipes will prevent the discharge of oil into the building, full consideration should be given to the desirability of encouraging their use. In Fig. 3, it is to be noted that in case the underground storage tank is located above the level of the oil burner, the installation of the automatic pump above the level of the top of the tank, and the carrying of all pipes between the pump and the tank through the building wall and to the pump in such a manner as to keep them always above the top of the tank, provides an effective means for preventing siphoning, and in the case of those pumps equipped with an automatic shut-off, designed to cut off the power supply to the pump in case of an abnormal discharge caused by a break in the supply line between the burner and the pump, we have a definite limit to the amount of oil that may be discharged into the building in case of a pipe breakage.

A means for venting of tanks is also one which, while covered in a general way by Rule 3[1], is frequently not understood. We find tanks located in the building with the vent openings not connected by piping to

[1]Rule 3 of the Regulations on Domestic Oil Burning Equipment reads as follows:
(a) An open or automatically operated galvanized iron vent pipe without trap and draining to the underground storage tank shall be provided.
(b) Inside or above ground and auxiliary tanks shall be provided with open vent pipes.
(c) All vent pipes shall be of ample size to prevent abnormal pressure in case of fire or when filling, in no case to be less than 1-inch pipe size; such vent pipes shall have the lower end extend through the top into the tank for a distance of not more than 1 inch. Outer ends of vent pipes shall be provided with weather-proof hoods, screened to prevent obstruction by insects and terminating at a point outside of building preferably not less than 3 feet, measured horizontally or vertically from any window or other building opening.

the outside of the building, and we find the tank vent openings bushed down, and pipes even as small as ⅜ in. carried to the outside of the building for venting purposes. A vent as small as this obviously is sufficient to prevent the creation of a vacuum when drawing the oil from the tank to the burner, but it is not sufficient to take care of more extreme conditions such as will be encountered when filling the tank rapidly or in the case of a fire. All tanks located inside of a building should have vent pipes carried untrapped to the outside of the building with pipes of the same size as the vent connection on the tank. If tanks are of larger capacity than 10 or 15 gal., these vent pipes should be of at least 1 in. standard iron pipe size. In those cases where the main storage tank consists of a reservoir of a capacity of around 200 gals., and from which the oil is transferred from this storage tank to the gravity tank by means of a hand pump, both the gravity tank and the storage tank may be connected to the same vent, and the piping extended through the wall to the outside of the building. All vents should be arranged so that there will be no possibility of traps which will serve to collect any obstruction to the free flow of vapor or air.

Gauges for use in tanks inside of the building frequently are of a type which introduces an opening that may be classed as a vent opening, and although generally of small size, such openings are subject to practically the same objection as would be the case if the regular vent opening were not piped to the outside as previously mentioned.

In the case of vents for underground storage tanks, it is to be noted that although Rule 3 (c) states that the vent pipe shall be of ample size to prevent abnormal pressure in case of filling, the minimum of 1 in., as mentioned, is all too frequently considered as being ample for all conditions. As a matter of fact, in the majority of installations, the present day practices are such that this 1 in. vent is ample. However, where heavy oils are used, the oil dealer is now usually found to be delivering the oil from the tank wagon by means of a power pump through a hose tightly connected to the fill opening of the underground storage tank. The purpose of this method of delivery is to cut down the time of filling the underground tank and enabling the tank wagon driver to supply a larger number of customers within a given time. In such cases, a vent pipe larger than 1 in. undoubtedly should be used. The exact size to be employed naturally is dependent upon the rate of delivery from the power pump on the tank wagon. The danger encountered with this combination of rapid filling and small vent, occurs particularly where the driver underestimates the available capacity of the underground storage tank. This results in the underground tank being subjected to considerable pressure when the oil level reaches the top of the tank and the liquid attempts to

escape through the small vent. A considerable number of tanks have been ruined and the oil lost, in some cases finding its way into buildings, where this method of filling has been employed. It is of course obvious that if the vent pipe is of ample size damage to the tank will be avoided, but where overfilling occurs, the result will be that oil will be discharged from the vent line with a resulting condition more or less hazardous, depending, of course, upon the location of the vent pipe terminal. If this terminal is carried up the side the building, it is obvious that any considerable amount of oil escaping may be sprayed over the side of the structure, or, as actually happened where the vent had been located above a roof, oil may be poured on to the roof of a building and carried away through the gutters and down spouts. It has been more or less jokingly suggested that if such methods of filling are to become a practice, it might be well to insist that the vent pipe terminal be so located that the discharge of oil will be quickly evident to the operator; in other words, so arranged that it will be pointed directly at the man making the oil delivery. Fortunately in most cases, as before stated, oil is delivered to small domestic installations by gravity, and a 1 in. vent is ample, as the underground storage tank is not subjected to pressures in excess of that caused by the height of the oil in the tank.

In spite of the fact that Rule 4 specifies that all filling pipes terminate outside of buildings, we frequently find a desire on the part of installers and home owners to locate the inside storage tank close to a window opening, and to expect the tank wagon man to place the faucet hose through the window and insert it in the fill opening of the tank. This naturally results in the discharge of more or less vapors into the basement, and in the case of overfilling, certainly introduces a hazard that may be avoided by strictly following Rule 4. All filling operations for oil burner tanks, where the filling is the initial delivery of oil by the oil man, should be carried on outside of the building, and the fill openings should be so located as to prevent the possibility of flow of oil or vapor through basement doors or windows. Where auxiliary tanks, such as shown in Fig. 2, are installed, the general method of filling is as indicated by the illustration. This method of installation is covered by rule 9, and 10 (a),[1] but when the so-called auxiliary tank is used as the principal storage, as is sometimes the case in very small installations, and as hereafter will probably be more frequently encountered on account of the increase in the gravity tank capacity from 60 gals. to 275 gals., as per action taken at the last annual meeting of the National Fire Protection Association, then it becomes necessary for the installer to observe Rule 4.

The installation of a standard type of pump in the pipe line, as shown

[1]See footnote page 160.

by Fig. 2, is one which is sometimes carelessly done, in that the pump is merely attached to the piping and not secured in any manner to the wall or floor of the building. All standard pumps listed by Underwriters' Laboratories for this particular purpose are provided with bases or other means for rigidly attaching them to the wall or floor of the building. This particular feature is not shown by Fig. 2, as the drawing of the pump in question is more or less conventional in form, and not in sufficient detail to indicate the wall attachment. It should not be necessary, in discussing the typical installation shown by Fig. 2, to point out the need for running an overflow line from the auxiliary tank to the underground storage tank. Strange as it may seem, many installations have been made in which no overflow line is provided, as well as omitting the necessary vent pipe, and in such cases the operator may, and frequently does, overfill the auxiliary tank. The writer has personally seen a number of instances in which the basement floor around the auxiliary tank was well soaked with oil.

After discussing the venting and filling of tanks, the next step brings us to the question of gauging or otherwise determining the quantity of oil in any of the storage tanks. The most common practice in this connection is the use of the fill opening for the insertion of a gauging stick. Obviously when the underground storage tank is located under a building, as is often necessary, it is impossible to introduce a gauging stick through the fill opening, and in such cases it is very common practice to make use of what is termed the "test well." Practically speaking, this is a second pipe similar to the fill pipe shown on Figs. 1, 2, and 3, but since when the tank is in the building the cap of this pipe is inside, it is obvious that when it is open we have a direct opening from the storage tank into the building. Any forgetfulness on the part of the user of the test well, resulting in leaving the cap off, naturally permits a direct passage of vapors into the building when filling the tank, and likewise introduces the pos-

9. FILLING OF AUXILIARY TANKS.

(a) Unless filled as specified in Rule 4 auxiliary tanks shall be filled by pumping from storage tanks.

(b) Tank shall be provided with an overflow connection draining to storage tank. Overflow pipe shall be not less than one size larger than supply pipe from pump.

(c) The overflow pipe of an auxiliary gravity tank shall not be provided with valves or obstructions; but overflow pipe of auxiliary pressure tank shall be provided with inter-connected valves or other means for automatically venting tank when filling.

10. PUMPS.

(a) Oil pump used in filling auxiliary tank from the main storage tank shall be of approved type, secure against leaks, with check valves located as close to pump as convenient. Pumps shall be rigidly fastened in place.

(b) Automatic pumps not an integral part of the oil burner shall be of an approved type preferably provided with automatic means for preventing continuous discharge of oil in case of pipe breakage.

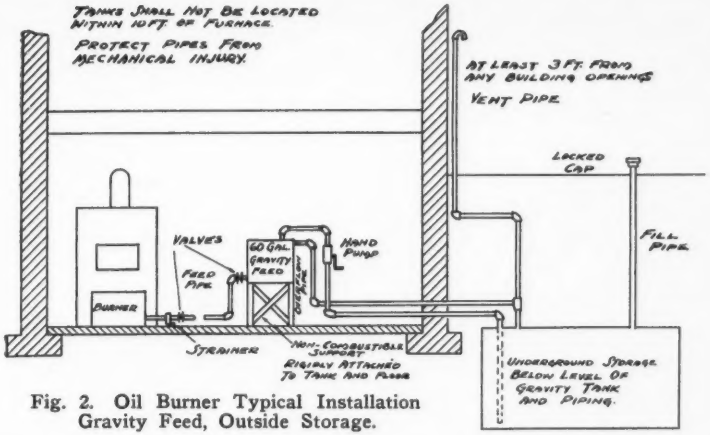

TANKS SHALL NOT BE LOCATED WITHIN 10 FT. OF FURNACE.
PROTECT PIPES FROM MECHANICAL INJURY.
AT LEAST 3 FT. FROM ANY BUILDING OPENINGS
VENT PIPE
LOCKED CAP
FILL PIPE
VALVES
60 GAL. GRAVITY FEED
HAND PUMP
FEED PIPE
BURNER
STRAINER
NON-COMBUSTIBLE SUPPORT RIGIDLY ATTACHED TO TANK AND FLOOR
UNDERGROUND STORAGE BELOW LEVEL OF GRAVITY TANK AND PIPING.

Fig. 2. Oil Burner Typical Installation Gravity Feed, Outside Storage.

sibility of the discharge of oil into the building if the tank should be overfilled. In the writer's opinion, the use of test wells is less excusable at the present day than it has been in the past. There is now on the market and included in the listed devices standard gauging equipment of sufficient accuracy, which serves practically every purpose of the test well and which eliminates the possibility of discharge of oil or vapor into the building under any normal condition of filling. Gauging devices of this type enable the owner to determine the amount of oil remaining in the tank, permitting him to gauge the quantity of oil delivered, and if properly observed by the delivery man materially reduce the possibility of overfilling a tank. The devices referred to do not involve the use of glass, the breakage of which will permit the discharge of oil or vapor into the building. Consideration may well be given at the present time to the desirability of either eliminating the old-fashioned "test well" or limiting its use to the necessary emptying of the tank when, as sometimes happens, water is delivered with the oil, or oil of an improper grade has been placed in the tank and must be removed. The use of such a device for removing liquid would be confined to such tanks as are located under buildings, and instead of installing the device as a test well it could be a second suction line with the pipe extending very close to the bottom of the tank instead of several inches above the bottom of the tank, as is generally the case with the suction pipe connected with the oil burner.

In the setting of tanks, buried underground, outside, or under the building, or installed inside of the building, the most frequent cause of trouble is in the character of tank foundations. Rule 7 very clearly states that tanks shall be set on a firm foundation, but all too frequently we find

that instead of a smooth level surface for the tank, the installer leaves the excavation with depressions and rocks at such points where contact is made with the tank surface in such a manner as to create undesirable strains. In making an excavation for a tank, the bottom of the hole should be smoothed off, and where rock and gravel are present, any inequalities should be eliminated by a slight fill of well tamped sand or earth. Where the character of the soil or other surface on which the tank is to be placed is such that some form of foundation is necessary, special tank supports must be prepared. These supports must be properly placed in order to prevent undue stresses on the tank. In this article no attempt will be made to suggest any particular means for determining the proper amount, but obviously, in the case of a long tank, it should not be assumed that a brick or concrete saddle at each end will be sufficient. In such an installation we have the mechanics of a beam uniformly loaded, and supported at each end. Such an installation may very readily result in injury to the tank, the loss of oil, and in causing a serious fire hazard. It would be far better to have several saddles located not more than two or three feet apart, thus uniformly distributing the supports throughout the length of the tank, and avoiding unnecessary stresses in the structure.

It is also well to point out at this time that when burying underground storage tanks, Rule 2 (c), which calls for coating the outside of tanks with asphaltum or other rust resisting material, should be carefully observed. The asphaltic or other paint coating applied to the tank by the manufacturer, is of principal service in keeping the tank in good condition up until the time when it is ready for installation. It is obvious that any tank coating applied at the factory must be more or less injured due to rough handling in transportation and installation. Every underground tank, whether made of galvanized metal or plain steel, and irrespective of the apparently good condition of the coating applied by the tank manufacturer, should be thoroughly coated on the outside with tar, asphaltum, or other suitable rust-resisting material. It may also be said that in some locations, such as for example where a tank is installed in filled ground, the corrosive condition of the soil may be such as to warrant further protection. Probably the best suggestion to make in such a case would be the use of an ample coating, consisting of a rich mixture of Portland cement and sand.

When installing tanks, installation men all too frequently are of the opinion that the tank may be rolled over and dropped into the excavation Numerous instances have been cited where tanks so handled have been seriously injured. The only excuse for such a procedure is the saving of time, and this saving is never such as to warrant the practice. Unfortunately, perhaps, tanks are generally so well constructed that the in-

staller's experience has not caused him to fear the possible results. Tank manufacturers have cited instances of two and three thousand gallon tanks being dropped into holes 10 and 12 ft. deep, the bottoms of which were covered with rock and gravel. Those responsible for tank installation should strictly caution installation men to carefully lower the tank in place, and in case of unavoidable accident, to subject any suspected tank to a pressure test before covering it up. The manufacturer of the tank or his representative should be consulted as to necessary test procedure.

According to Rule 7 (d), inside storage, gravity and auxiliary pressure tanks shall be provided with incombustible supports securely attached to the tank and to the building structure. This, of course, applies principally to tanks of not over 275 gallons capacity, such as are permitted by Rule 1 (b). The need for securing such inside tanks, as specified by the rules, was clearly illustrated in a recent fire in one of our Eastern cities where a gravity tank not properly secured to its support and bolted to the basement floor was floated from its support, the pipes broken, and oil discharged on the surface of the water. If this tank had been installed strictly according to Rule 7 (d), and otherwise conformed to the regulations regarding piping and venting, the oil would have remained in the tank, irrespective of the amount of water in the basement.

Rule 8 of the regulations, which applies to gravity and pressure tanks, is one which has been frequently questioned. The most frequent question with regard to Rule 8 (a) has been how to determine the capacity necessary for a one day supply. This particular rule has been altered by the previously mentioned action of the Association at its last meeting, and the limit for such gravity tanks will now be 275 gals., irrespective of the daily consumption. Any need, therefore, to discuss the difficulties of determining a one day supply is avoided.

Rule 8 (b) requires a gravity tank to be 5 ft. from any fire or flame, and requires a pressure tank to be 10 ft. away. The writer believes that both types of tanks should be installed at least 10 ft. measured horizontally from the furnace, or from any fire or flame.

The use of automatic pumps which are not an integral part of the oil burner has been becoming more common. These devices serve as a ready means for avoiding the use of inside tanks. Their principal appeal to the owner of the oil burner equipment is the practically constant supply of fuel without the need for any attention on his part. Their use, of course, reduces the necessary presence of the householder at the frequent intervals which would be required where an auxiliary tank of limited capacity must be filled each day. Just how much is lost or gained by this additional automatic feature is more or less a matter of opinion, as there are probably no data available for comparative purposes. It is

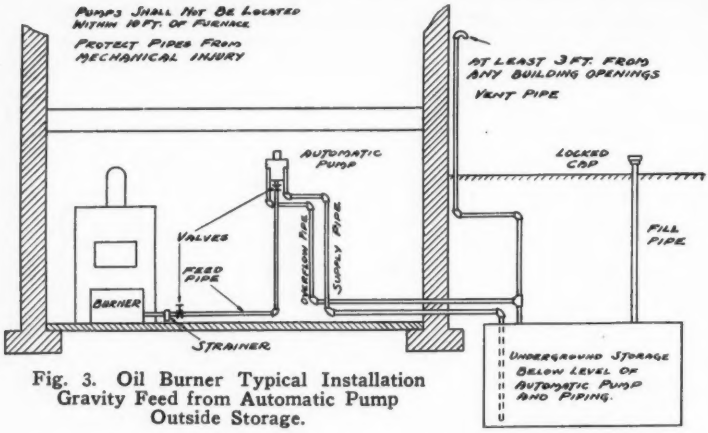


Fig. 3. Oil Burner Typical Installation Gravity Feed from Automatic Pump Outside Storage.

also obvious that if an automatic device is employed it always will be ready to supply oil, irrespective of whether the demand is from the oil burner through the proper channels or through the breakage of a pipe connection. For this reason, Rule 10 (b) states that such pumps **shall** preferably be provided with automatic means for preventing the continuous discharge of oil in case of pipe breakage. Automatic pumps now listed by Underwriters' Laboratories are provided with this automatic feature, and are designed to limit the amount of oil which may be discharged into the building in case of the breakage of the pipe to an amount considerably under that which might escape in the case of the breakage of a pipe connected to the ordinary gravity tank. To secure this desirable condition, it is necessary that such automatic pumps be installed strictly in accordance with the manufacturer's directions. The size of the piping to be used, and the lengths as well, should not be varied in order to meet any special installation conditions. Such variations may very readily result in nullifying the automatic shut-off feature.

It may also be noted that where the automatic pump is installed in connection with a tank, the top of which is above the lowest pipe used in connection with the oil burner, the pump if installed above the level of the top of the tank will serve as an anti-siphoning device. In such cases it is strictly necessary to install both the suction line and the overflow line from the automatic pump to the tank in such a manner that the pipes are all located above the top of the tank and so secured that in case of any breakage there will be no opportunity for the pipe to drop below the level of the oil in the outside storage tank, and thus introduce the possibility of siphoning.

So much has been said with regard to the proper piping of oil burner installations that it really should not be necessary to add much more at this point. However, it is always safe to speak of the desirability of making all pipe joints tight, as there is probably nothing more objectionable than an unsightly oil stain at each and every oil joint, such as has been all too common in the past.

Rule 11, on the subject of piping, clearly indicates that the piping should be carefully protected against mechanical injury in a manner satisfactory to the inspection department having jurisdiction. Unfortunately it is not always possible for the inspection department to check up on this point, and we find piping running over the floor and exposed in a manner which, given time, ultimately will result in damage and leakage of oil. Where it is absolutely necessary to run a pipe across a floor a very substantial guard should be placed over the piping, and this guard should be rigidly secured to the floor. Piping should be run in corners between the side wall and the floor, and in such cases it may not be necessary to provide any extra protection, but even so, proper guards would not come amiss. Many manufacturers are instructing their installers to run the piping under the floor. This arrangement is ideal insofar as the question of damage and breakage is concerned, but it of course makes it rather difficult to clear the piping of any water or dirt which may accidentally come into it.

Rule 11 (a) states that in all piping systems, proper allowance should be made for expansion and contraction, jarring, and vibration, and in the case of some burners, this brings up a point which has been rather difficult to solve, and which, in fact, has until very recently had no definite and recognized solution. The last sentence in Rule 11 (a) prohibits the use of tubing of any kind, which prohibition was based, at the time the rules were drawn, on the prevalence of light wall seamless tubing, and on very delicate, easily injured flexible tubing or hose. Underwriters' Laboratories' List at the present time contains reference to flexible tubing which has been found to withstand very severe service when employed in a very definite and prescribed manner. Tubing of this class, and there will probably be a number of manufacturers prepared to supply it within a short time, serves a very useful purpose in cutting down the transmission of undesirable vibration, which is sometimes encountered in the case of motor operated burners. The material is not to be considered as a substitute for standard full weight iron pipe or brass pipe of equal strength but, when permitted by local authorities, will serve a very useful purpose, and as before stated, if properly installed, may be expected to have a tendency to reduce the possibility of injury to the piping by vibration, to say nothing of eliminating or minimizing the transmission of undesirable

sound. It is to be expected that proper consideration will be given to the revision of the rules to recognize material of this kind when properly installed.

Rule 12,[1] relating to valves, needs little explanation, but as we so frequently find the use of valves which are not provided with a standard form of stuffing boxes, it may be well to point out that where a stuffing box is not of liberal size, and is not provided with a removable cupped gland, we frequently find that the user has difficulty in making the packing box tight, and often when replacing the packing, inadvertently allows a few strands of the packing material to get between the threads of the packing nut and the corresponding threads on the body of the valve, and when tightened up, gives an impression that the packing box is tight, whereas the fact is, the packing is compressed a very little, and probably will leak. Standard types of valves are more readily obtained on the market today than formerly. It has often been the case in years past that the manufacturers of oil burners have said that it was impossible to get small valves of the size used on oil burners without giving a special order. Standard types of valves are now obtainable from a considerable number of manufacturers, and there is really no excuse for the use of an improper valve in an oil burner installation.

Rule 16 (a) states that the ash door of the furnace shall be permanently removed, or else bottom ventilation provided to prevent the accumulation of vapors within the ash pit unless burner is of a type which mechanically purges the ash pit. We frequently find that in the case of some types of burners where there is no reason for expecting that the operation of the device will purge the ash pit, the front opening is completely plugged up by fire brick and cement. With some types of burners it is necessary to reduce the amount of air flowing through the air door opening, but especially in the case of natural draft burners, this opening should not be completely blocked, and a definite opening, as close as possible to the floor level, should be provided. This rule also recommends that when the ash door is closed, other doors of the furnace should be arranged to swing from the top, or some other means provided to relieve pressure sometimes caused by puffs or back fire due to delayed ignition. This particular rule has caused some comment, and in the case of competitive arguments, it

[1] 12. VALVES.

(a) Readily accessible valves shall be provided near each burner and also close to the auxiliary tank in the pipe line to burners.

(b) Control valves shall be of approved type provided with stuffing box of liberal size, containing a removable cupped gland designed to compress the packing against the valve stem and arranged so as to facilitate removal. Valve shall be designed to close against the supply, and to prevent withdrawal of stem by continued operation of the handwheel. The use of packing affected by the oil or heat is prohibited.

has been pointed out that this indicates a hazardous condition found alone in oil burners. Speaking directly from actual experience, the writer has had more severe puffs or back fires when handling coal fires than ever experienced when handling properly designed and installed oil burners. It is quite true that there has been some rather severe so-called explosions of oil-fired furnaces, but in practically all of the instances investigated, these have been due either to faulty installation or to a householder making adjustments contrary to the manufacturer's operating instructions. Dampers in pipes or at any point in the furnace either should be removed, or if for any reason it is felt necessary to have some control on the draft, a section should be cut out of the damper so that irrespective of the damper setting, it will not be possible for more than 80 per cent of the internal cross-sectional area of the smoke passage to be shut off. In the case of a recent report of severe smoke damage, said to be caused by improper operation of the domestic oil burner, it was found that the installer had not followed the rule [16 (c)], but had to his own satisfaction secured an equivalent. This was done by wiring the handle of the damper in such a manner as to prevent it being closed. Unfortunately it happened that when the householder felt it was desirable to clean the smoke pipe, the wiring was removed, and when piping was replaced, the damper accidentally was completely closed. As a result of this, the burner when started up, continued to pour products of combustion into the furnace, and the only egress was through the front of the heater.

Rule 16 (e),[1] which it will be noted is a recommendation rather than a specific requirement, is one which should be of interest to any user of a domestic oil burner. Manufacturers of oil burners do not consider it a part of their duty to insist on the equipment of the furnace with definite means for preventing undue temperatures or pressures. Many manufacturers regularly furnish what are known as "aqua-stats" or "pressure-stats," which are automatic in operation; in other words, so arranged that when properly connected, they serve to stop the operation of the oil burner until the pressure or water temperature has dropped to a predetermined point, at which time they again close the circuit to put the burner motor into operation, if at the time the room thermostat is calling for heat. It will be obvious that if for any reason the room thermostat is held in the "on" position, either on account of the radiator having been turned off or on account of a window being left open, the oil burner will continue to operate automatically. Continued normal operation of this char-

[1] 16 (e) It is recommended that where automatic operation is provided by means of a room thermostat the installation should be equipped with an additional thermostatic control to prevent abnormal water temperature, abnormal steam pressure, or overheated hot air furnace ducts. Such automatic shut-off device should be so arranged that it must be reset manually.

acter may easily result in the loss of a considerable quantity of water, and in some cases, has been known to ruin the furnace, or even to start a fire through overheated pipes. The automatic shut-off device referred to in Rule 16 (e) is a device entirely apart from the ordinary "aqua-stat," "pressure-stat," or other automatic temperature control. It is to be noted that the last sentence in the rule says that this shut-off device is to be arranged so that it must be reset manually. Such devices are adjusted so that they will not operate within the same temperature or pressure range as the other automatic controls. Being set at a higher temperature they are not called into service until an extreme condition is reached, and when such occurs, serve to shut down the operation of the burner permanently and to prevent injury of the boiler or possible loss by fire. It is of course true that if these ultimate safety devices should perform their desired function at a time when the householder is absent, we would be confronted with the possibility of freezing. In answer to this question of two evils, it is better to choose the lesser. It is hardly to be questioned that it is preferable to incur a plumbing bill, owing to injury to piping through freezing, than to pay for a new furnace or for a fire loss.

Rules 18 and 19,[1] relating to instruction cards and installation, although last in the pamphlet of the Regulations and occupying but a few lines of space, are extremely important. Every oil burner listed by Underwriters' Laboratories, is required to be furnished with a complete instruction card printed on substantial paper in a form that may be placed under glass and framed by the user. The householder should thoroughly familiarize himself with this instruction card, and in case of any doubt call on the oil burner manufacturer or on the service man or dealer who made the installation. An earnest attempt has been made to edit the instructions so as to secure proper operation of the oil burner; but the important link between these instructions and satisfactory operation of the burner is the application of a reasonable degree of intelligence in following the guide provided. In a case of the more simple type of burners, such as the natural draft burners, installation instructions also are shipped with the burners so that in case of installations remote from dealer, the purchaser will have a guide to follow in making the installation. It must be agreed that the practice of having the purchaser make his own installa-

[1]18. INSTRUCTION CARD.

A card giving complete instructions in regard to the care and operation of the system shall be permanently posted near the apparatus. Said card shall be placed under glass and framed.

19. INSTALLATION.

Oil burning equipment shall be installed only by properly qualified mechanics experienced in this kind of work. It is recommended that systems be installed by the manufacturer.

tion is not to be encouraged, but where it cannot be avoided, it is believed that the installation instructions are sufficiently complete to enable a man of reasonable intelligence to secure proper conformance to the installation regulations. In the case of a more elaborate burner, the manufacturers furnish their dealers, jobbers, and installers with very complete installation manuals, which in some instances are in loose leaf form so that they may be added to and revised readily from time to time as occasion demands. Strict conformance to the installation regulations and the exercise of reasonable intelligence on the part of the user, and the refraining from attempts to "improve" on either the adjustments or the installation of the burner by those not properly qualified will certainly result in avoiding the possibility of the great increase of the use of domestic oil burners having any material effect on the national fire loss.

The Portland, Maine, Fire Department has devised this scheme for maintaining clear aisles and windows securing excellent cooperation on the part of property owners in putting the plan into effect. A card placed in the window indicates from outside the building the windows which are clear and which lead to aisles. The reverse of the card serves as a notice to the occupants of the building to keep the window and aisle clear. The above illustration shows at the left the side of the card which faces out and at the right the side which faces into the building.

The Structural Factor in Fire Prevention.

By S. H. Ingberg (Member N.F.P.A.).

U. S. Bureau of Standards.

Estimates of the relative importance of a structure and its structural environment as factors in fire prevention have varied widely. Nearly all buildings have combustible contents and the fire loss on contents is at present nearly equal to that on the structures themselves, considering all types. The fire-resistive type, by which is meant the type able to withstand a complete burn-out of contents without structural collapse in any part, is open to attack not only from within but also from some of the more severe exposures from the outside. This article discusses exposure fires communicated to fire-resistive buildings and the change in conditions which would follow change in the predominating type of construction in a given city or district.

The Fire Loss Components.

In order to appraise the value of the structure as a fire retardant we must take into account all main factors that enter into our fire loss. We first have the property loss that now approximates $500,000,000 per year. We next have the cost of public and private fire protection, which in some of our larger cities now equals or exceeds the property fire loss. The total cost for the whole country for this item is probably less than one-half of the property loss since a large part of the fire loss is on property that has little or no fire protection. The other large item in the national fire loss bill is the cost of insurance. The part of the insurance premiums that goes toward payment of fire losses balances itself out on the loss ledger and does not increase or diminish the aggregate burden. The other part that constitutes the cost of insurance exclusive of any profits must be taken into account as it represents the time of workers and the cost of all accessories incident to the operation of the insurance machinery. The cost of writing, collecting and accounting the many small items constituting the premium total, and the cost of adjustment of fire losses, big and small, should be expected to constitute a considerable portion of the total amount involved. The indications are that this cost is approximately equal to one-half of the property loss. Hence the cost of fire protection and of insurance that jointly can be termed the

From a paper read before the 1926 Annual Meeting of the Building Officials' Conference at Columbus, Ohio. Published by permission of the Director of the Bureau of Standards of the U. S. Department of Commerce.

cost of the menace of fire, equals approximately the property loss itself as taken for the country as a whole.

There are other items, such as the loss in production and wages caused by fire; and, most serious of all, the large loss in life variously estimated at from 10,000 to 20,000 per year. The value of proper building construction as a factor in life safety will be given first consideration.

The Protection of Occupants.

As it concerns industrial, commercial and public buildings occupied during working hours, the type of construction from the safety to life standpoint is secondary to providing adequate means of exit and protection of such exits. Since egress should be effected in a few minutes, smoke tightness is as essential as fire resistance. The superiority of fire-resistive construction in this respect commends itself, although it is ineffective where large amounts of readily combustible materials and building trim are present with vertical and horizontal openings unprotected. The elimination of combustible floors and trim in very high buildings is without doubt justifiable on this score as adequate exit facilities for such buildings can seldom be provided. Lower buildings can be made reasonably safe from the standpoint of safety to life irrespective of the interior construction by the use of a sufficient number of protected exit ways. The type of exterior walls or finish is unimportant in this respect. Few lives are lost in exposure fires or spreading fires such as conflagrations unless preceded by abnormal disturbances such as tornadoes or earthquakes. In parts of the world where the building construction is more readily combustible than ours, loss of life from rapidly spreading fires in communities with closely spaced houses is frequent. Our largest loss of life is in buildings of institutional and residential occupancies, and so far as it concerns the building as a factor the greater portion of the loss occurs at night. The improvement in this respect for hotels, clubs, apartments and lodging houses subject to state and municipal regulation has been very marked, although considerable life hazard still exists, particularly in old buildings that have not been made to conform with the most elementary requirements, and in seasonal resort hotels that neither in their construction nor housekeeping are subject to public regulation. Hospitals and asylums need to be of superior construction on account of the longer time of exit that must be allowed and the inherently greater hazard from the occupancy.

The private residence remains as the point where the greatest loss of life occurs. So far as it concerns the building and its accessories as cause, the immediate remedies available appear to consist in protection of the heating equipment and chimney and the elimination of combustible wall and ceiling finish. Plaster as a fire retardant varies in effectiveness

with the materials of which it is composed and the base on which it is applied. All plasters during the initial period of the fire are smoke-tight and afford no opportunity for spread. Fire-stopping to prevent rapid spread from basement or lower story to upper stories helps where the fire gains headway before the occupants become aware of the danger. The enclosure of stairways and provision of not less than two means of exit from all portions of the house are effective remedies but apparently hard to obtain. It would appear possible without unduly changing our ideas of stairway design to provide enclosures at the top of all stairways. Where two stairways cannot be provided, windows and doors can be made to open on verandas and veranda roofs, escape to which will afford temporary safety from smoke and fire and generally give sufficient time for rescue. The character of the exterior finish being of importance from the standpoint of safety to life mainly for protection against grass and brush fires in some rural communities, and against arson, the major structural change that can be applied refers to the interior. Either incombustible fire-resistive construction would be required or the protection of all combustible members with a finish of enough fire resistance to permit complete or nearly complete burn-out of contents without ignition of these members, a protection apparently difficult to obtain in all its details. The floor finish and interior trim should also be incombustible for best protection. The contents with residential occupancy being moderate in amount would afford little opportunity for spread of fire. It might be stated in proof of the possible effectiveness of the structure when utilized to its limit in this respect, that in parts of southern Europe where wood is so scarce that it can be afforded by the rich only, and then chiefly for floor finish, loss of life in residential building fires is of extremely rare occurrence.

The Building as Hazard and Protection.

Having briefly considered the responsibility of the structure from the standpoint of safety to life we come back to its consideration for general fire prevention purposes. It will be necessary to consider first the manner of functioning of the different building types and building members under fire conditions.

1. *The Frame Building.* Taking the frame building finished on the outside and inside with combustible materials, a maximum opportunity is afforded the fire to start and the building offers little or no retarding effect on the spread. The rate at which it burns depends on the size of the members and their arrangement, large members and solid construction without concealed spaces being the less conducive to spread. Fire stopping and incombustible interior finish will help retard the progress of the fire within. The walls or roof of such buildings will not help to restrain the flames or spread of embers and brands, and hence the hazard

to the surrounding construction is a maximum, which increases with the building area and height.

2. *Incombustible Exterior Finish.* The next type is the wood framed building finished with an incombustible finish on the outside, such as stucco, sheet metal or masonry veneer, that helps to protect it against exterior exposure, the degree of protection being dependent on the temperature insulation afforded by the covering. When the building is once on fire, whether from origins inside or outside, its status with reference to hazard to the surrounding structures approaches that of the board finished building.

3. *Incombustible Exterior Bearing Walls.* The next in the scale of fire resistance is the building with incombustible exterior bearing walls, depending in the case of multi-story buildings for lateral support on the interior frame. The walls generally have sufficient thickness to afford protection against exterior exposure as long as they remain standing. With all incombustible exterior wall finishes and walls, the ability to resist exposure is limited by unprotected openings, such as windows and doors, that may be in the wall. In all buildings such openings are permitted when the wall is a certain distance from the lot line or adjacent building, which depends on the size and occupancy of the building, varying from a few feet to 30 feet or more. However, such openings of moderate area with respect to the total wall area do not wholly nullify the protecting effect of the wall as the latter forms a barrier behind which the fire attempting to enter at the openings can be fought. Under conditions of interior fire the masonry walled building will retain the burning material better than the types previously named. The progress of the fire within can be retarded by the use of large timber members without concealed air spaces as in standard mill construction, by the use of incombustible finishes for partitions and ceilings and by fire stopping. With interior plaster finish the amount of combustible materials is less than one-half of that in the building with combustible outside and inside finish. In this type would also fall the building with interior unprotected or insufficiently protected incombustible framing.

A complete burning out of buildings of this type means collapse of floor and roof construction and generally partial collapse of the exterior walls. The building will hence burn as a unit and the volume of flame and hot gases will be greater than if confined by the floors and roof, and after the progress of the fire beyond a certain point the building will not effectively confine them or the flying brands produced by the fire. The blanketing effect of the roof covering will help, but unless it is incombustible or highly fire retardant, and well tied together, little effect can be expected, when the framing beneath it has collapsed.

4. *The Fire-Resistive Type.* The next to be considered is the fire-resistive construction with protected exterior and interior construction that can withstand a complete burning out without collapse of any major member. The building contents and any combustible trim will burn each story or fire division thereof independent of the others, hence the volume of flame and hot gases will be very much less than for buildings burning as a unit. Also the major part of the construction offers no fuel for the fire. The hazard to the surrounding buildings is lessened by the stability of the outside walls and roof construction which remain in place throughout the fire. The wall openings afford the only channel for flames, hot gases and burning embers to escape. The spread of the fire within such buildings will be retarded by suitable partition construction and by the use of incombustible floor finish and trim, although these do not give full assurance in this particular, even for the occupancies involving minor amounts of combustible materials, such as office, institutional and residential, unless possibly as equipped with incombustible fixtures and furnishings.

5. *Protection of Openings.* The necessity for the protection of exposed wall openings, such as by wired glass and metal doors or shutters, is apparent, but its consideration will be included here only as it concerns the structural background for such protection. The main essentials are a wall construction that offers an assuredly greater fire resistance than the opening protection, and structural protection of the whole exterior of the building. It avails little to protect the wall area when the fire can enter through the roof. Many buildings with well protected major roof and wall areas have combustible cornices and towers through which fire, particularly under conflagration conditions, can enter the roof space at points where extinguishment is difficult.

Building Code Requirements.

Building codes and fire regulations recognize the different degrees of hazard or fire resistance afforded by the various building types and details described, the location within the city where they can be built, distance from the property lines, and limitations on area, height and, occasionally, on occupancy. So far as it concerns dwellings, we made an inquiry about a year ago relative to spacing of dwellings on lot, wall openings permitted, and separation between families in multiple dwellings. A questionnaire was sent to the building officials of 50 representative cities. The results of this inquiry are as follows:

1. *Scope of Information Presented.* Information was received from 37 cities in reply to question asked, some of which also sent copies of their building, dwelling or zoning codes. Information on all points was, however, not received from all the cities. The population of these cities,

according to the 1920 census, is about 19,000,000, which is approximately 30 per cent of the population living within the incorporated cities and villages.

2. *Separations between Units in Double Dwellings: Two Occupancies side by side.* In ten cities nothing is required. Three cities require stud partitions, plastered on both sides, three require the hollow space between studs to be filled with masonry, three require the studs to be covered with metal lath and plaster on both sides. One requires a partition having a one-hour fire resistance where the outside walls are wood frame, and masonry walls same as the outside, where the outside walls are of masonry. Five cities require incombustible walls, without any specification as to thickness or fire resistance, and one city requires 12-inch masonry walls. In three cities limitations are based on ground area from 2500 to 5000 square feet between masonry walls.

3. *Separations between Units in Duplex Dwellings: Two Occupancies one above the other.* Sixteen cities require no special provisions. Twelve require fire stopping at floor and ceiling lines. Four require plastered ceilings, two of which require the plaster to be on metal lath. One city requires a double board floor with building paper between board layers.

4. *Status of the Double Duplex Dwelling without Fire-Resistive Division Walls or Floors of Masonry.* In 14 cities information at hand indicates that such a dwelling would not be permitted. In 17 cities it would be permitted sometimes with limitations on area and requirements relative to fire-resistive interior finish or fire stopping.

5. *Separation between Units of Attached Dwellings (Row Houses):* (a) *Wood frame construction covered with wood on outside.* In 10 cities this type of attached dwelling is not permitted. In 26 cities it is permitted sometimes with restrictions as to area between masonry division walls. One city requires division walls to be plastered. Two cities require metal lath and plaster on wood studs between the units. One city requires metal lath and plaster partitions for every third family occupancy. Three cities require the hollow space between studs to be filled solid with masonry. One city requires double walls of studs and weatherboard with no connection between them. Sixteen cities require masonry division walls between units. For some cities this is expressed in terms of area limitation from 1200 to 3500 square feet or lateral spacing of masonry walls from 40 to 50 feet, or both. In three cities the masonry walls are required to be of 12-inch thickness. In three cities ground areas from 4000 to 5000 square feet are allowed between fire walls, permitting, in the case of one city, as many as four families in the area between them.

(b) *Wood frame construction covered with brick veneer or stucco.* In almost all cases the requirements for separation are the same as where

the outside is covered with wood. One city requires 6-inch masonry walls dividing units, where it permits metal lath and plaster for (a).

(c) *Outside masonry construction with interior wood framing.* One city requires metal lath and plaster partition for every three families. Four cities require space between studs to be filled with masonry. One city requires double walls of studs and weatherboarding with no connection between them. Four cities require 8 or 12-inch fire division walls of masonry between fire areas of from 4000 to 6000 square feet. Twenty cities require masonry fire division walls between units or between units exceeding 2200 square feet. In four cities these masonry walls must be not less than 12 inches in thickness.

6. *Spacing of Dwellings from Side Lot Lines.* In a great number of cities the spacing of dwellings on the lot is governed by considerations of light and ventilation, the spacing being included in the zoning laws. The zoning laws generally make no distinction between the different types of construction. The spacings given are the minimum spacings for two-story dwellings and in a few cases for one-story dwellings. Increases from one to two feet are required for each additional story.

(a) *Wood frame construction covered with wood on the outside.* In two cities the minimum spacing permitted is 18 inches from the lot line, in thirteen cities 3 feet, in eight cities 4 feet, in four cities 5 feet, in one city 6 feet, in one city 7 feet and one city 10 feet from side lot lines. In four cities this type of dwelling may be built on the lot line if without openings.

(b) *Wood frame construction covered with brick veneer or stucco on the outside.* The requirements for this construction are generally identical with those for wood frame construction covered with wood on the outside.

(c) *Outside masonry construction with interior wood framing.* The requirements where openings are present in the walls are very nearly the same as for (a), wood frame construction covered with wood. This construction, however, is generally permitted to be built on the lot line if without openings.

7. *Number of families permitted between masonry division walls.* Generally the number is not specified as it is governed by the area and construction limitations given under 2, 3, 4, and 5. Two cities limit the number specifically to one family. Three cities limit the number to one family per floor, two cities to two families, three cities to three families and three cities place a limit of four families as a maximum to be accommodated between fire walls of masonry. Most of these cities also have in addition certain area limitations.

8. *Restrictions on openings in walls of dwellings.* Generally, when dwellings are spaced at given distances from the lot lines there are no requirements on the area of openings or the protection required for the openings. When the construction is built to the lot line the walls are required to be without openings. When less than a certain distance from the lot line five cities require the openings to be protected by metal frames and wired glass.

9. *General Comments.* All of the cities have fire limits within which only masonry walled buildings can be built and where, obviously, the requirements for the all wood frame buildings do not apply.

Referring to the cities with the most progressive codes, the requirements indicate fair attempts to recognize the relative merits of the different building types. Other codes need constructive revision. There is need of greater recognition for incombustible and fire-resistive finishes on exterior walls and interior partitions and ceilings between families. Double floors with incombustible felt between them appear desirable for duplex houses. Partitions between units of attached houses with masonry exterior walls, giving less than complete protection in case the adjacent unit burns, appear indefensible, particularly where the different units are built for individual ownership. Considering the opportunity for spread afforded, it is doubtful whether blocks of attached houses should be permitted, unless outside and dividing walls are of fire-resistive construction. This seems to be the only method by which fire division between units, both through wall and roof areas, can be obtained with certainty. Without adequate parapets dividing the roof area there would be rapid spread of fire over the roofings ordinarily used for frame buildings.

The Building as a Fire Barrier.

Coming now to the general value of the building in checking the spread of fire it is admitted that conflagrations can occur in almost any city where the predominating type is other than fire-resistive. That they do not occur is due to the vigilance of the fire departments. Such protection will for a long time be necessary and everything should be done to promote fire-fighting efficiency. At the same time it seems logical to plan the construction of a city so that such a menace and its attendant large cost will gradually be eliminated.

A suggestion, first made by Albert Blauvelt (QUARTERLY, Vol. 8, No. 1, page 21), involves dividing a city into fire divisions by two intersecting streets, the buildings on both sides of these streets suitably protected against exterior exposure. A city plan involving extra width for these streets or avenues would help to attain the desired object.

Fire experience indicates that the predominance of the fire-resistive

building type, in a given district, notwithstanding its limitations, will in large measure eliminate the conflagration hazard. That this is so for the buildings of minor size can be assumed without discussion, provided there is some minimum of public fire department protection. The test comes in the congested centers of large cities with buildings high in proportion to the street widths on which they front. The large conflagrations of the past, while they have involved fire-resistive buildings, have not given positive information on account of the predominance of the non-fire-resistive types in and adjacent to the burned district. In the case of the San Francisco earthquake and fire of 1906 about 40 fire-resistive buildings were involved, none of which suffered total collapse although all suffered varying amounts of structural and other damage. Regarding structural conditions one observer[1] writes:

"Inflammable wooden buildings, remnants of the pioneer days of 1849, were scattered throughout the business districts and added fuel to the flames. The magnificent high steel structures that were gutted by the fire, owe their disaster for the most part to their environment by these inflammable buildings."

In the congested district 2.2 per cent of the buildings were of fire-resistive construction (which means a somewhat large percentage of the area built upon), 68.2 per cent were wood joist masonry walled buildings and 29.5 per cent were frame throughout. The total extent of the fire was 2593 acres (about four square miles), 490 city blocks, and it is not surprising that these 40 fire-resistive buildings should be enveloped and their combustible contents and trim ignited by the hot blast created by the surrounding buildings. When once on fire they added their share to the heat total.

In the case of the Baltimore fire of 1904 somewhat similar conditions obtained. Joseph Kendall Freitag,[2] who examined the ruins shortly after the fire, says: "By the time the fire reached the large office buildings, near the center of the northern boundary, the area in flames consisted of 20 or more blocks of non-fireproof buildings, and, before one is too critical as to the behavior of the supposedly fire-resisting buildings, it is well to consider what a tremendous heat must have been driven with the flames—an intensity of heat no construction could have been expected to wholly withstand."

In the Chicago fire of March 15, 1922, the Burlington Building of fire-resistive construction was partly burnt out from fire entering through unprotected openings, as a hot blast from a burning block of non-fire-resistive buildings across the street. It effectively blocked the progress

[1]Frank Soule, U. S. G. S. Bulletin 324, p. 138.

[2]Fire Prevention and Fire Protection, 1st Ed., p. 158.

of the fire and apparently prevented what might have assumed the proportions of a conflagration. All of the other conflagrations, of which we have had an unfortunately large number, did not involve fire-resistive buildings, or at most only a few.

Present information supports the following conclusions relative to the fire-resistive type: (1) where a conflagration that has gained considerable headway in a district built up with non-fire-resistive buildings, reaches a district built on exclusively with fire-restrictive buildings, it is to be expected that the buildings of the latter type immediately exposed and without protected wall openings, will be damaged and in part or whole burnt out; and that with moderate protection and fire fighting the other buildings of the fire-resistive group will not be ignited. (2) That in a district entirely built up with fire-resistive construction and with ordinary office, residential and commercial occupancies, excluding such occupancies as regulations generally prohibit in congested districts, a fire cannot spread beyond the control of moderate fire fighting effort. (3) That with office, residential, institutional, and the lighter mercantile and manufacturing occupancies, fires can be and generally have been confined to portions of the story where they originate, by the help of moderate fire fighting effort, even where the maximum of combustible trim usually permitted in fire-resistive buildings is present.

Prevention of Fire Damage.

This article has so far dealt only with the building from the standpoint of public regulation of construction. The owners' and insurers' interest goes farther, in being concerned with the damage caused by the fire other than the collapse of main members. With buildings of non-fire-resistive construction the salvage after the fire is quite small, outside masonry walls, where present, being generally damaged by the fire and the collapse of the interior construction. There are, however, instances where the interior construction has been rebuilt after the fire on the original well-constructed walls. Most of the fire-resistive buildings involved in the conflagrations of the past were constructed before there was available much knowledge on how to protect building materials and construction against fire damage. The earlier tests conducted here and abroad gave information mainly on strength and stability during the fire. With the knowledge now available, it is possible to construct a building at little added cost that will come through a fire with a minimum of damage. The damage to a building of this type from a complete burning out has been found to be from 30 to 60 per cent. By the intelligent use of materials the percentage of damage can be reduced below the lower limit named. On a building costing several million dollars this means a great saving. A considerable portion of our effort in the work on the

fire-resistive properties of materials is devoted to development of methods to reduce the fire damage. With the increased knowledge gained from field experience and laboratory tests on how to protect against outside exposure and restrict the spread within, it is not difficult to construct a building for a given location that will not be appreciably affected by fire in the surrounding structures and will suffer a minimum of damage from those originating within.

The Twilight Inn Tragedy.

Another chapter in the infamous history of the resort hotel has been written. Twilight Inn, a popular resort hotel in the Catskill Mountains, near Haines Falls, N. Y., burned in the early morning hours of July 14, 1926. After three days of frantic search, 14 bodies had been taken from the ruins. Many persons were injured in the course of the fire and many more suffered hardship from exposure.

The hotel was a typical three-story frame building. The fire is supposed to have originated on the first floor in the servants' quarters, and was first discovered by the night watchman who apparently found the fire then beyond control and devoted himself to rousing the guests with

Courtesy Fire Engineering.

Twilight Inn before the fire which cost the lives of 14 people.

Wide World.

Ruins of the Twilight Inn, Glens Falls, N. Y., where 14 people were killed in the fire which destroyed this Catskill Mountain hotel on July 15.

the help of other servants. He lost his life doing this, but the occupants of the hotel who escaped probably owe their lives to his alertness. So rapidly did the fire spread that many persons only saved their lives by jumping from the upper windows, thus sustaining severe injuries. The corridors and stairways of the building apparently became impassable early in the fire, and many of the victims were hopelessly trapped in their rooms.

Calls were sent to the fire departments in Tannersville and Palenville. The former, three miles away, arrived first, but found the fire so advanced that they devoted their efforts to saving nearby cottages. In this they were successful. Their operations were hampered by lack of water and by the fact that the hotel was situated on an extremely steep slope of a hill. The Tannersville pumper got water from a creek 1600 feet away and 200 feet below the road level.

Newspaper stories said that this is not the first time that a fire had occurred at the Inn, but at each previous time the fire had been extinguished while small. The hotel was apparently without fire protection. The owner of the hotel, a prominent New York Democrat and financier, is reported by the papers to have made the comment that the fire could have been handled easily with the fire equipment at hand *if the fire had not spread so rapidly!*

Hot Bearings.

By Edward N. Harriman.
(Member N.F.P.A.)

Hot bearings are responsible for annual fire losses running well into the millions. No exact statistics are available, but hot bearings are probably responsible for the major part of the losses classified by the Actuarial Bureau of the National Board of Fire Underwriters as "Friction-sparks caused by machinery," averaging some $8,000,000 annually.

What was a blessing to the Neolithic aborigines, enabling them to build fires by friction, has in this age become a curse. In 10,000 years we have not fully learned that friction generates heat and the generation of sufficient heat induces combustion.

As early as 1450 the scientist, Leonardo da Vinci, studied the question of friction in bearings and came to the conclusion that "heat is produced, and is dependent upon the surfaces which are rubbing—and upon the lubricant." It was he who evolved a "bearing shaft of highest perfection for clocks, saws, etc. . . . The arrangement makes rotating movement last so long after the motive power has stopped that it seems wonderful and supernatural." This is probably the first reference which has come down to us on anti-friction bearings which, as their name implies and as Leonardo discovered, almost eliminate friction, generate practically no heat, and consequently cannot cause fires.

An interesting article recently appeared in the *Grain Dealers' Journal* which brings to light very clearly the importance of bearings as fire causes in mills and elevators. Experts indicate that hot boxes are the chief cause of fire in these plants and they recommend that ball bearings or roller bearings be used wherever possible especially in elevator heads, boots, electric motors, fans and conveyors. The following is an excerpt from this article:

> The largest cause of fire, both by number and amount of losses, is the Unknown Cause. Among the known causes of fire in flour mills and elevators Hot Boxes ranks third in the amount of property destroyed. If it were possible to know how many of those classed as unknown were in reality caused by a hot box, this cause would without doubt top the list.
>
> We have had hot box fires originate in all conceivable places. Picking a few at random, we find them originating in bearings on a grain cleaner, a water wheel, elevator head shaft, electric motor, line shaft, idler pulley, bolter, and conveyor.
>
> All operators realize the possibility of danger from cleaner bearings and those on line shafts, but one of the principal sources of trouble, and strangely little thought of, is the electric motor bearing. This is one of the easiest bearings to care for in

a mill or an elevator, and many times is one of the most neglected. We have definite records on a number of fires from this particular cause.

The most neglected bearing there is in a mill is the conveyor bearing. The reason is that it runs slowly and there seems little chance for trouble. One such loss occurred last year in North Dakota. A hot box on a screw conveyor taking stock from a tubular dust collector set fire to the conveyor and to the collector. A similar fire occurred in Buffalo early this year when a bearing on a conveyor taking stock from the roll suction set fire to the conveyor and the fire communicated through the metal dust collector to the outside.

Elevator head and boot bearings cause a great deal of trouble. Sometimes they are hard to get to and consequently do not receive the attention they should. Boots especially are neglected.

The large per cent of trouble with cleaner bearings has been those on the fan. In some of the older types of cleaning machines these bearings are partly or completely inside the fan case. All such are difficult to oil. They get gummed up on the outside with oil and dust and eventually set fire to the housing. All such bearings should either be set out from the fan casing or the casing away from the bearing and replaced with metal fastened to the casing in such a way that the bearing is entirely outside the case.

During the past ten or twelve years there have been several attempts to equip various of the heavy duty machines in flour mills with ball bearings. From a fire prevention standpoint they are fine, but they are not generally used. The owners of several mills which have complete ball bearing equipment on their shaftings are apparently well satisfied.

Roller bearings are adaptable in many instances, not only on shafting, but on machines as well.

All wooden bearings should be eliminated. Even on a very slow running shaft they are hazardous.

The most unfortunate explosion and fire, which occurred at the Corn Products Co. resulting in a tremendous loss, was caused by an overheated bearing in a conveyor (see QUARTERLY, Vol. 17, No. 4, p. 354). In the last 16 years hot bearings have caused losses totaling approximately $1,358,000 in this particular industry and most of these losses were preventable with ordinary caution. It would be interesting to know how many fires have been caused in the same way in other industries where flammable dusts, liquids, and vapors are hazards incident to the processes of manufacture.

There are two requisites in every perfect machine. One is that all the parts must be accurately made and properly adjusted one to another; and the other is that every bearing shall always have the right kind and proper amount of oil. You even oil your lawn-mower when you use it and you grease the axles of the humble wheelbarrow when they squeak. The big engine which runs the machinery for a whole factory is watched over constantly and oiled frequently by an attendant. Most machines, even if in need of attention, will perform their functions for a short time,

though perhaps more slowly, but of course always at the expense of wear and rapid depreciation.

Plain Bearings.

Plain bearings require no explanation as nearly everyone is familiar with them. They are of various types, identified by their names. Grease packed, waste packed, oil, ring oil, oil-less and self-oiling all have one common characteristic; that is, that the lubricant provides a film between the stationary and rotating parts, the lack of which even for a short period will cause the bearing to heat and often burn out. Those who have had the misfortune to run their automobile engines without oil appreciate the seriousness of its absence.

Anti-Friction Bearings.

Anti-friction bearings consist of an inner and outer ring or race, between which balls or rollers roll on hardened polished surfaces. The inner race is mounted on the rotating shaft and the stationary outer race in a housing. Lubrication is used only to maintain the highly polished surfaces and to decrease wear in the retainers which separate the balls or rollers. Very little lubrication is necessary for this function, and this is decidedly advantageous when certain types of mechanical appliances are considered. For example, it is particularly important in the application of anti-friction bearings to electric motors.

Electric motors are being used more commonly than ever before both in direct connected and in small group drive units. These motors are in many instances located in inaccessible places and lubrication is often neglected. With plain bearings this is particularly dangerous, yet with anti-friction bearings it need scarcely be considered as actual records show that only about one in every 25,000 anti-friction bearings fails because of faulty lubrication. Neglect in lubrication of a plain bearing causes immediate failure; ball and roller bearings run on their initial lubrication six months or even a year without any additional attention. As a matter of fact the manufacturers recommend that anti-friction bearings be lubricated only once every six months since an excess of lubricant causes a churning action in the housing. The oil seal in an anti-friction bearing also serves to keep out all dirt and abrasive dusts the introduction of which into any bearing will cause rapid wear and loss of efficiency in operation.

While the subject of electrical motors is being discussed, it might be well to consider the causes which bring about fires in these motors and also methods of prevention. Statistics show that 72% of all motor troubles are directly due to bearing failures, and included in this figure is a startling record of fires which followed these breakdowns. Plain bearings, as has been shown, require frequent and copious lubrication and the best of the class are not oil tight. In the case of electric motors,

oil leaks into the windings, breaks down insulation and short circuits the field. Practically all types of anti-friction bearings are oil sealed in such a manner that oil cannot escape from the bearing housing. Even the most improved type of plain bearing will wear appreciably due to the rubbing action of the shaft. In induction motors, where the air gap is small this wearing is very serious because with this wear the air gap is destroyed, the rotor drops, strikes the stator and a fire may occur. Anti-friction bearings, by contrast, show comparatively little wear, not more than a few ten-thousandths of an inch in several years, and in the event of the failure of a ball or roller, the rotor cannot drop since the remaining balls and rollers will hold it in its proper place.

With the wear of plain bearings also comes vibration, which in turn causes breakdowns in delicately adjusted machinery, short circuits in electrical units, fires and resulting delay and expense to the industry. Because anti-friction bearings do not wear noticeably, there is very little of this destructive vibration, parts are kept accurately in position as there are none of the strains and vibrations which aggravate unusual wear and destruction of the bearing. A prominent manufacturer of anti-friction bearings has stated that approximately 17% of the electric motors now in service are equipped with ball or roller bearings and that their records show that not one has ever been reported as having caused a motor fire.

Operating in steamy or gassy atmospheres, with metal and carbon dust, around furnaces or on cranes which handle heavy loads and often exposed to high temperatures are all factors contributing to the short life of bearings. A burned out plain bearing in a situation such as this is a common occurrence and even though the property loss itself may be small the loss due to interrupted production is often great. Plain bearings are especially susceptible to these troubles while anti-friction bearings with their sealed housings are an important factor in eliminating this weak link in production.

Household appliances requiring a motor as part of the unit are in an increasing number of instances being equipped with ball bearings. Plain bearings, neglected, burn out and cause fires; anti-friction bearings require almost no attention in these appliances and to date have not been charged with a single fire. Domestic oil-heating equipments, a new development which, on account of continuous duty more closely approximates the conditions of factory service, are almost universally equipped with anti-friction bearings.

It has been possible to cite only a few of the more important applications of anti-friction bearings, but further study of the subject by fire prevention engineers is urged. Many fires which are now attributed to spontaneous ignition, electrical defects, "unknown" causes and those fires

which occur after the plant shuts down for the day might perhaps be charged to overheated bearings. There is no question but that the dripping of oil from plain bearings is a distinct fire hazard.

The following uses of anti-friction bearings are recommended as a fire prevention measure:

1. Motors in inaccessible locations.
2. Ventilation fans.
3. All bearings where the dust explosion hazard is present.
4. All bearings on machinery used in the presence of flammable gases.
5. On woodworking machinery.
6. Bearings exposed to abrasive dusts or extreme heat.
7. On all machinery used actually in the manufacture of flammable materials (viz: celluloid, rubber cement, cotton pickers, etc.)

Fire Record—Hot Bearings.

The N.F.P.A. Department of Fire Record started in March, 1925, a cross-reference file of reports of fires due to hot bearings. Up to September, 1926, there have been received 63 reports of fires due to this cause. In this number are included a few fires of importance occurring prior to 1925.

This record has been prepared solely from the viewpoint of the hot bearing as a fire cause and is unlike the usual fire records published in the QUARTERLY in that it is not concerned with the amount of loss, the fire protection used, the method of discovery and such features which are not germane to the particular matter under analysis.

These 63 fires occurred in properties of every sort of occupancy showing that this is a hazard which is likely to cause fire in any class of property. The greatest number of these fires, however, occurred in occupancies where there is apt to be present readily combustible dust or flyings which may be easily ignited by the hot bearing and spread the fire. Twenty-eight of the 63 fires reported occurred in cotton mills and other textile occupancies. Nine fires occurred in paper mills and 8 in woodworkers of various kinds. The other fires were widely distributed as to occupancy.

The records show that where the fires did not start and spread in combustible dust or flyings from the material handled, oil soaked wood or dirt in the vicinity of the bearings was frequently to blame. Careful attention to bearings, and mounting them on incombustible bases, should eliminate a large part of this hazard.

It is obvious that practically all of these fires were the result of neglect of bearings. For the most part the original reports do not go into details as to the exact reason for the heating of the bearing, but in an occasional instance the reports cite specific failure to lubricate bearings. Similarly the original reports in only a few instances give indication as to the exact type of bearing which was responsible for the fire. In the absence of specific descriptions of the bearings, it may be assumed that in most cases they were the plain type rather than ball or roller bearings. The following are summaries of typical fires due to hot bearings.

Typical Fires Due to Hot Bearings.

S-37160. STARCH FACTORY. Fire originated at an overheated bearing in screw conveyor carrying starch. The casing of this conveyor was of wood. The flames from the burning casing ignited a dust cloud formed when a load of starch was dumped into a hopper 15 feet away. The ensuing dust explosion killed 42 men, injured 22, and did property damage amounting to approximately $750,000. (For further details of this fire, see QUARTERLY, Vol. 17, No. 4, Page 354.)

S-40319. COTTON MILL. Fire occurred on an old English spinning frame which had several bearings of the iron to iron type instead of babbitted bearings. A hot bearing at the spindle drive end of the frame set fire to the oily lint. Fire flashed over the entire length of the machine and opened two sprinklers which practically extinguished the fire. In this mill there was one man whose duty was to oil all spinning frame bearings daily. Apparently this oiling was neglected in this particular case, as no defects in the bearing appeared which might have caused trouble if the oiling had been done faithfully.

S-42283. WOOD BOX FACTORY. Fire occurred at a planer, caused by an overheated bearing at the drive pulley. A small oil feed pipe which lubricated this bearing had been broken and the bearing became dry. The fire broke out about three hours after the planer had stopped operating for the day, it probably having smouldered for some time before discovery. The fire was extinguished with small loss.

S-40876. COTTON MILL. Fire originated in the bearing of a napping machine. It was extinguished by the operation of one sprinkler head and a number of fire pails and chemical extinguishers. The bearing was examined after the fire and the oiling chain was found hung up on the ball bearing race and not operating properly.

S-41002. COTTON MILL. Friction at a right angle shaft transmission at the ceiling of the card room set fire to dust and flyings. This burning material soon dropped to the floor and ignited cotton and dust

under and around machinery. The fire was extinguished by sprinklers and extinguishers with comparatively small loss.

S-42526. Newspaper Printing Plant. A laundry for washing dirty rags used in cleaning printing presses was operated as a part of this plant. The fire occurred in a motor used for metal drum dryers in the laundry and was confined thereto. The cause was lubricating oil accumulated inside of motor casing and around bearings ignited by an overheated bearing.

S-41594. Cotton Mill. Fire occurred in the picker room due to a hot bearing. The conveyor belt slipped off the pulley and it was here that the fire started. It is not clear whether the actual ignition was caused by the hot bearing or by the belt. In either case the bearing was the primary cause, as it was responsible for the slipping of the belt. Fifteen sprinklers operated and held the fire in check until hose streams could be brought into play.

S-40195. Woodworker, manufacturing excelsior. A hot box on one of the excelsior machines caused a fire which rapidly spread to adjoining machines which were spaced close together and caused 90 sprinkler heads to open which checked the fire but which caused large water damage.

S-40149. Rubber Reclaiming. A hot bearing developed on the "cracker" in the devulcanizing building. This ignited old oily dust around the bearing. The fire was extinguished with water buckets.

S-39819. Pulp Mill. An employee was loading a bucket elevator carrying sulphur when he noticed smoke which instantly became very dense due to the ignition of very fine sulphur dust on the sides of the conveyor housing. The mill fire brigade responded and lines of hose were run. After the fire was extinguished the cause was determined as an overheated bearing on the bucket elevator. The loss was approximately $1,000.

S-40291. Paper Mill. Fire started at one of the cylinder bearings of a paper machine, caused by overheating of the bearing. The fire spread over the machine and ignited the cotton dryer felts. The fire was subsequently extinguished by sprinklers and hose.

S-40795. Woolen Mill. Fire originated in a large motor used to drive cards and caused a loss of approximately $1500. As nearly as could be determined after the fire, the fire originated in the motor due apparently to the burning out of the inner bearing allowing the rotor to drop and strike the field, burning out the motor and setting fire to a wooden belt enclosure.

S-38995. BLEACHERY. Fire was caused by an overheated bearing on an exhaust fan over a dyeing machine. This fan exhausts the steam from the hood over the machine to a frame pent house on the roof. Directly under the bearing there was a rubberized cloth placed to prevent oil from the bearing dropping on goods in the dye machine. Sparks from the bearing dropped on this cloth and ignited it. The fan drew the fire into the pent house. The damage was confined to the hood of the machine, the exhaust fan and the pent house and roof.

S-38857. MATTRESS FACTORY. Fire occurred in a picker and mattress filling machine due to cotton lint on the shafting near the bearings which was ignited by friction. The fire was extinguished by pails of water and the damage confined to the stock.

S-39657. COTTON MILL. Fire originated from a hot bearing in the frame ropeway adjoining the picker house. The ropeway was very oily and the fire spread quickly through it and to the wheel house. Further spread was prevented by the operation of sprinklers and hose streams. The ropeway and wheel house were destroyed and other portions of the property damaged with a loss estimated at $25,000.

Baltimore Oil Tank Fire.

Report by Association of Fire Underwriters of Baltimore City.

(Member N.F.P.A.)

An oil tank fire, on August 10, 1926, originating during the filling of a tank truck with gasoline, reached considerable proportions and completely destroyed twelve tanks and the warehouse of the American Oil Company at one of their distributing stations. One man was fatally burned.

Construction and Occupancy.

The warehouse and office building was of brick with an ordinary roof. It was one story, 15 feet in height and an area of 2326 sq. ft. Open windows were in the walls facing the oil tanks. The warehouse section of this building was used for the storage of lubricating oils and greases in barrels and cans. Inside this building several tanks from 100 to 580 gallons in capacity were used for storing and blending lubricating oils.

Tanks Nos. 1-5 (see picture page 193) were horizontal, resting on brick cradles with the tanks 18 in. to 8 ft. above the ground. These tanks were of all metal construction with riveted and caulked joints. Each of the tanks had openings in the top with manhole covers of the screw type, and venting was through 1½ in. gooseneck vents with no screens. These tanks had no dikes but were enclosed by a poorly constructed brick wall on three sides. The tanks ranged in size from 11,700 to 20,000 gallons, and two of them were used for the storage of gasoline and one each of the others contained alcohol, kerosene and lubricating oil.

Tanks 6, 7 and 8 were setting vertically on concrete foundations. They were 28 ft. in height by 8 ft. to 10 ft. in diameter having capacities from 16,000 to 23,000 gallons. They were of all metal construction with vents and manhole covers in the top. The vents were 1½ in. in diameter with gooseneck and screen of 40 mesh. The manholes were bolted. The brick dike of poor construction surrounding these three tanks had a capacity only equivalent to that of the tanks. The construction of this dike was of 8 in. brick, 13 ft. high with no header courses of brick to form the proper bond and the mortar used was of a poor quality and applied too dry. These tanks were used for the storage of gasoline, and gasoline mixed with benzol.

Tanks Nos. 9 and 10 were filling tanks used for the storage of alcohol and kerosene. These tanks had a capacity of 2,000 gallons and were of metal construction with a 1½ in. vent. They were set on an angle-iron frame 8 ft. high.

Courtesy Baltimore News.

American Oil Co. fire about an hour after it started. Tanks containing 100,000 gallons of gasoline and benzol mixtures are burning.

Tank No. 11 used for the storage of fuel oil, had a capacity of 18,000 gallons. It was set horizontally on steel supports 10 ft. high with a concrete foundation. A 1½ in. vent was screened with single 40 mesh. An 8 in. cement brick dike 6 ft. high, surrounding the tank, had a capacity of 25,800 gallons.

Tank No. 12 was used for the blending of gasoline and benzol with air, used for agitating. This vertical tank was of all metal construction having a capacity of 42,000 gallons. The steel roof of the tank had two 2 3/16 in. vent pipes with air regulator at the outlets. There was no dike around this tank.

The plant is located in the city limits and is under the protection of the Baltimore City Fire Department and water supply. Standard watchman and clock service was being maintained using A. D. T. combination boxes. The first aid equipment consisted of one 35 gallon foam tank on wheels.

The Story of the Fire.

The fire originated in an automobile tank wagon which was being filled with gasoline at tank No. 3, but the cause cannot be definitely determined as the owners refused to give any information; the tank wagon driver was fatally burned. The records of the fire department state that

Panoramic View of the American Oil

it was back fire from the auto truck; but from other sources it was reported to have been static electricity.

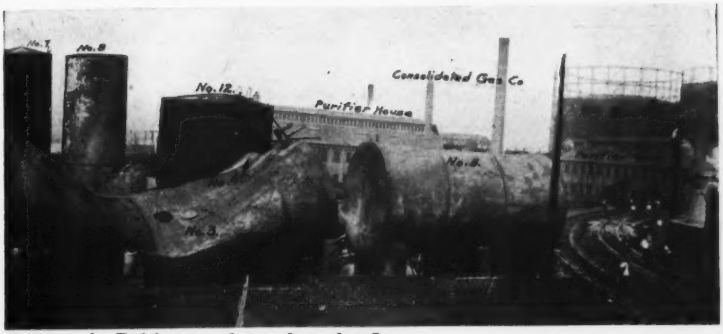
The driver of the truck was the first one to discover the fire and other employees transmitted alarms through an A. D. T. box and a public fire alarm box at Clarkson and Wells streets, at 5:27 P. M.

One hose company, eight truck companies and 35 engine companies responded to the six alarms which were sent in for this fire.

The tank truck was being filled through a gravity connection from the bottom of tank No. 3 and no doubt this arrangement allowed burning gasoline to spread very rapidly throughout the area. The congestion and proximity of the tanks, together with the noticeable poor quality of construction of supporting and enclosing walls, permitted the fire at the first tank to readily spread to the entire group, as was to be anticipated. The fire department responded promptly and rendered good service in practically surrounding the tank group with a curtain of water, but, even so, dwellings 50 feet distant caught fire and were extinguished with difficulty.

An adequate water supply furnished over twenty good fire streams. Foam was also used but seemed to have been of value only in connection with preventing the spread of fire outside the property, by checking the blazing oil as it flowed on the water formed by the hose streams. The horizontal tanks collapsed and dropped to the ground but the vertical ones remained intact. The brick walls and dikes were light, very poorly constructed and of small capacity. In some places they were 13 ft. high and generally failed under the conditions obtaining. No violent explosions were reported and it was noted during the fire that the vertical tanks burned from the explosion vents.

The fire was confined mainly to the oil plant property but burned until the contents were practically consumed. The No. 11 tank dike of



Company's Baltimore plant after the fire.

cement brick totally collapsed and the bricks disintegrated. The only tank saved was No. 13 containing 42,000 gallons of benzol that was detached 30 ft. to the south. This was kept cool by hose streams. This tank was surrounded by a cement brick wall 6 ft. high, built without any foundations extending below ground. When the cooling water from the hose streams being played on the tank rose to a height of about 2 ft. within the enclosure, the wall facing the fire completely overturned. The weather conditions fortunately were most favorable, with but little breeze stirring, otherwise it is doubtful whether the fire would have been confined to the plant. During the fire the Consolidated Gas, Electric Light and Power Company had earth embankments thrown up around their main buildings to prevent the oil and water from the burning property flowing inside. They also pumped all gas from the large holder nearest the fire.

The eight horizontal tanks and their contents, a capacity of 94,400 gallons, warehouse building and contents, three auto trucks and three tank cars and contents are a total loss.

It may be possible to use again the four vertical tanks, but their contents, a total of 100,000 gallons, were completely burned. The rear portions of four dwellings were considerably damaged.

Conclusions.

The fire very readily involved the entire tank group with the exception of the benzol tank No. 13, detached about 30 feet, owing to the congestion and the poor construction. Cement and sand bricks used in part were found to disintegrate and fail completely under the temperatures developed, although clay brick remained unaffected under similar conditions.

The vertical tanks came through the fire in fair condition, apparently, but the horizontal tanks collapsed entirely. The fire clearly showed the

tremendous exposure to other properties that is carried from a tank wagon distribution, storage and blending station of this haphazard type and construction. Had each tank been installed vertically, properly constructed, detached, diked and equipped with standard vents, and the filling of tank wagons conducted by pumping instead of gravity flow, the fire might then have been readily confined to the tank wagon. If one or two of the tanks then became ignited at the vents, the flame could probably have been snuffed out.

The fire furthermore illustrates the well-known fact that neither streams of water nor foam are effective extinguishing devices for a fire of this type, once well under way. The most that can apparently then be hoped for contemplates the confinement of the fire to the group involved, which was accomplished in this case.

A plant of this character should never be located close to dwellings on account of the hazard to life, nor near any buildings which may serve as carriers for a conflagration. City authorities should not permit such an occupancy in such a location. Except for the very favorable weather conditions and the good work of the fire department, a conflagration might readily have resulted.

Drug Houses—Fire Record.

The following tables of fires in drug houses compiled from the reports of fires recorded in the files of the N.F.P.A. Department of Fire Record include 314 fires reported since the publication of the last previous fire record on this occupancy in the October, 1909, QUARTERLY (Vol. 3, No. 2, page 195).

In compiling this record an attempt has been made to include only reports of fires in drug manufacturing and wholesale houses, excluding retail drug stores, etc. Owing to the great variety of the products handled and the fact that in some instances the reports indicate the combination of drug manufacturing under the same management with retail drug business, it has been difficult to draw the lines of the classification very sharply. The special hazards of drug houses are many and varied. The manufacturing processes where fire originated represent a large number of separate fire causes. These are for the most part listed separately in the tables of special hazard fire causes, each drug or chemical responsible for fire being individually listed. It was felt that an attempt to combine a large number of these fires under a single heading, as is frequently done in the fire records of other occupancies, would detract from the value of the tables. It appears that in some cases the inspectors preparing the

original fire reports were not familiar with the character of the processes, and on this account in a few cases there is some doubt as to the exact process and material responsible for the fire. In each such case the fire has been listed as reported by the original inspector.

This record shows the predominance of special hazard causes in drug houses, the ratio of special hazard causes to common causes being higher in this occupancy than in many others. That these special hazard causes have not been responsible for a considerably greater loss than has been recorded has been attributed to the continuous fire prevention campaign carried on by the National Wholesale Druggists' Association (member N.F.P.A.). This record since 1909 shows 78 fires in this occupancy where the loss was $5000 or larger, only 12 of these having occurred in sprinklered properties. The table of sprinkler performance shows that in spite of the hazard of the occupancy sprinklers are effective, performing satisfactorily in 238 out of the sprinklered 242 fires reported since the N.F.P.A. Fire Record was started in 1897. Statistics of fire loss payments compiled by the Actuarial Bureau of the National Board of Fire Underwriters for the years 1923 and 1924 show under the heading "Mercantile—Drugs, Chemicals and Medicine, Wholesale" a total loss of $156,381 in 1923 and $294,496 in 1924.

Causes of Fires.

	No. Fires	Per Cent Known Causes
Common Causes	111	44
Special Hazard Causes	144	56
Total Known Causes	255	100
Unknown Causes	59	
Total	314	

Common Causes.

Smoking or Matches	28
Rubbish and Waste—	
Rubbish or sweepings in barrel igniting	11
Rubbish in front of boiler	4
Spontaneous ignition of oily material	8
Spontaneous ignition of waste paper	2
Spontaneous ignition of fuel	2
Fuel ignited	1
Lighting—	
Defective or short circuit in electric wires	8
Bulbs breaking or in contact with flammable material	3
Candle left burning	1
Gasoline lighting system	1

Common Causes, continued.

Power—	
Motor overheated	2
Short circuit in electric power lines	1
Overheated bearing in belt enclosure	1
Hot bearing in pulverizer	1
Float valve on filling machine failed	1
Spark from switchboard	1
Heating—	
Furnace	7
Defective gas pipe or plate	3
Defective chimney	2
Steam pipe overheated	2
Boiler	1
Open grate fire set fire to flooring through light cement insulation	1
Alcohol stove	1
Exact cause not stated	2
Lightning	2
Locomotive sparks	1
Thawing frozen pipes with blow torch	1
Fire crackers	2
Incendiary	3
Exposure	5
Rats and matches (?)	1
Fire not entirely extinguished and rekindled	1
Total	111

Special Hazard Causes.

Compounding, Heating, etc.—	
Creosol in contact with gas flame	4
Boiling over of a mixture of syrup	3
Paraffine ignited	3
Carbolic acid ignited while being heated	2
Camphorated oil ignited	2
Heating compound	1
Turpentine boiled over	1
Melting vaseline ignited	1
Balsam fir ignited from gas stove	1
Liniment boiled over	1
Kettle of chocolate boiled over	1
Back draft in distilling furnace	1
Gas from residue of a priscillic acid tank ignited from gas flame	1
Vessel of acid over a bunsen burner burst	1
Iodine ignited from gas stove	1
Heating flask of benzo alcohol	1
Mixing drugs too near gas stove	1
Drug kettle boiled over	1
Ammonia solution boiled over	1

Special Hazard Causes.

Compounding, Heating, etc., continued—	
Jar broke allowing aniline dye to come in contact with gas	1
Top of still blew off and contents ignited	1
Redistilling of alcohol	1
Ether sub-dividing	1
Insect powder overheated in a reel	1
Total	33
Grinding—	
Foreign matter in grinding machinery	18
Spark from grinding machine	8
Herb grinding machine (exact cause not stated)	2
Friction at herb grinding mill	1
Friction in spice grinding machine	1
Overheated grinding machine	1
Grinding mill, unknown	1
Friction in grinding mill containing cascara	1
Friction in drug mill	5
Friction in disc mill	1
Foreign matter in beater	1
Licorice root grinding mill overheated	1
Total	41
Chemicals—	
Spontaneous ignition of chemicals (exact substance causing fire not stated)	5
Spontaneous ignition in barrel of chemical chlorene	1
Chemical store room, cause not stated	1
Chemical reaction in mixture of calcined magnesia water and cleoresin cubeb and ginger being dryed	1
Spontaneous ignition in barrel of belladona	1
Total	9
Ignition of vapors—	
Alcohol ignited from gas stove	3
Alcohol ignited from a match or cigarette	3
Alcohol ignited from sparking motor	2
Alcohol vapor ignited from unknown cause	2
Alcohol ignited from heat of sun's rays	1
Alcohol ignited from gas jet	1
Alcohol ignited from watchman's lantern	1
Gasoline fumes ignited from gas stove	1
Can of carbon bisulphide ignited near a gas stove	1
Cover was being removed from ether still when flash fire occurred	1
Total	16
Explosions—	
Chemical explosion	5
Explosion of wood alcohol	1
Explosion of grain alcohol	1
Sterilizer explosion	1

Special Hazard Causes.

Explosions, continued —	
Acid explosion	1
Still exploded	1
Explosion in vault for storage of flammable material	1
Explosion of gasoline soldering iron heater	1
Explosion in ether and alcohol recovery building	1
Explosion, cause unknown	1
Total	14
Spontaneous ignition—	
Spontaneous ignition in bags of herbs and barks	1
Spontaneous ignition of yellow stick phosphorous	1
Spontaneous ignition in oil room	1
Spontaneous ignition of acids	1
Total	4
Drying—	
Drying (exact cause not stated)	7
Spontaneous ignition of drugs being dryed	5
Spontaneous ignition of chemicals in dryer	4
Gas pressure came up at night and longer flame ignited drying racks in closet	2
Overheating of dry box	1
Roots drying over boilers ignited	1
Calcium and magnesium oxide were not thoroughly hydrated and cooled before being incorporated into mixture	1
Total	21
Miscellaneous—	
Friction of shovel against wood barrel of barium peroxide	1
Experimenting with kerosene and sodium	1
Gas heater for incubator	1
Sulphuric acid leaked through flooring and came in contact with electric light wires causing short circuit	1
Soldering furnace too near a jar of paraffine	1
Oxy-acetylene welding	1
Total	6

ROOMS WHERE FIRE OCCURRED.

In 183 fires the reports included data as to the exact location of the start of the fire as summarized below. The other reports lacked the requisite data for inclusion in this table.

Drug manufacturing and compounding rooms	96
Basements	29
Storage rooms	23
Office, hallways and other non-manufacturing portions	15
Outside building	11
Boiler and engine rooms, etc	9
Total	183

ANALYSIS OF LOSSES.[1]

Sprinklered		Unsprinklered	
Small Loss	180	Small Loss	66
Large Loss	12	Large Loss	49
Total Known Losses	192	Total Known Losses	115
No Data	2	No Data	5
Total	194	Total	120

EFFECT OF SPRINKLERS.[2]

Practically or entirely extinguished fire	196
Held fire in check	42
Total Satisfactory	238
Unsatisfactory	4
Grand Total	242

Atchison, Kansas, Grain Elevator Fire.

Report by Kansas Inspection Bureau (Member N.F.P.A.).

A large terminal grain elevator at Atchison, Kansas, was destroyed by fire on Sunday, July 18, 1926, and nearly succeeded in taking a large portion of a residential section of Atchison with it, due to numerous fires started by the flying embers from the elevator fire alighting on wooden shingle roofs. This fire, therefore, is of interest from two standpoints—the fire in the elevator itself, and its conflagration features.

Construction.

The elevator was of ordinary metal sheathed frame built in 1911 and in reasonably good repair. About 30 feet north of the elevator proper were 10 cylindrical tanks intersecting one another, with reinforced concrete walls. These were used for the storage of grain. Interior walls of the bins stopped 10 feet below the roof so that there was a large common roof space above them. This roof space communicated with the distributor floor of the elevator by a belt conveyor gallery resting on steel beams covered with concrete slab. The gallery was open at each end.

Story of the Fire.

On this Sunday when the fire occurred the plant had been operating until 2:00 P. M., four employees being on the premises handling grain. The machinery in the elevator proper was shut down at 10:00 A. M. when the top cupola where the fire originated was visited for the last time by an employee.

[1]Small loss fires include fires where loss was less than $5,000.

[2]This includes all fires occurring in Drug Houses, where sprinklers have operated since the N.F.P.A. records were started in 1896.

The weather was hot and humid and a moderate south-southwest wind was blowing.

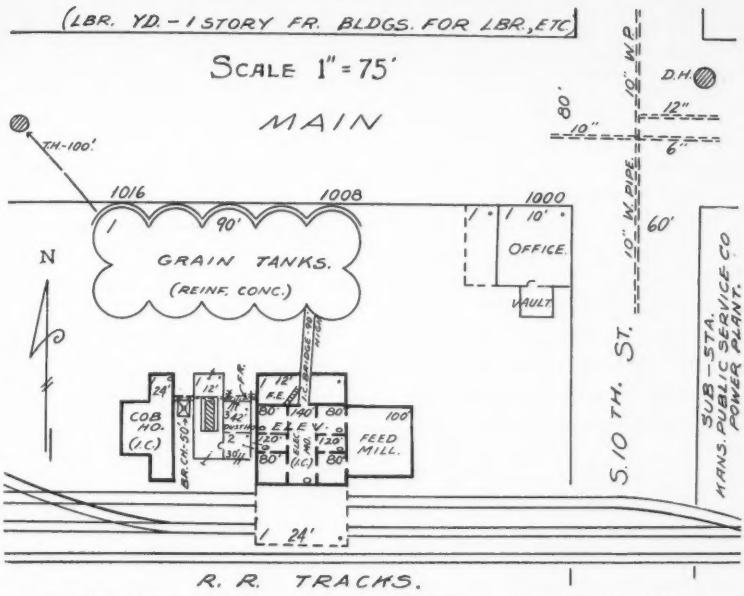
The fire, as has been indicated, started in the cupola at the topmost part of the elevator proper. It was noticed at about the same time by the captain of a fire station a few blocks distant from the elevator, by one of the employees who had just left the elevator, and by the superintendent of a neighboring flour mill who happened to be in the top story of his own mill. The captain of the nearby fire station promptly responded, having notified the other fire stations by telephone. The fire department was summoned by the manager but was already on the way.

It is not known what caused the fire. No one had been in the cupola for nearly four hours. A motor bearing which had caused trouble two weeks previously might have become faulty again. Electrical defects might have been developed; sparks from locomotives might have entered through the open windows; the fire might have started in an elevator boot and broken out at the head; and there are other possibilities. Fire department response was two combination chemical and hose wagons, two pumping engines, and an aerial ladder truck. The seat of the fire, 140 feet above the ground, was beyond the reach of hose streams, and the entire upper structure of the elevator was quickly involved. No means of reaching the upper part of the structure was available. Some of the fire apparatus was called away to fight fires which had been started by flying embers.

Flames shot through the almost fire-resistive conveyor bridge into the top of the concrete grain tank section where a number of windows had been left open, causing considerable draft. The grain in the concrete tanks was readily ignited and burned freely. Late in the afternoon fire fighting forces were augmented by two pumping engines from St. Joseph, Mo., one of which directed its attention to the elevator fire proper. The fire was then burning in the lower cribbed and slow-burning part of the elevator which collapsed toward evening.

A good water supply at a good pressure was available throughout the fire. No attempt was made to reach the burning grain in the concrete tanks by hose streams as water would have caused swelling of the grain and probably would have resulted in bursting of the tanks. Ten days after the fire this grain was still burning. It seems that the grain was not ignited through the walls of the tank but through the open overhead conveyor gallery and through cast iron covered manholes near the bottom of the two tanks which were in the direct line of the fire.

A long period of drought had preceded the day of the fire, making the wooden shingle roofs of the neighboring city a greater menace than usual. The city slopes upward from the elevator toward the north, to a point approximately 150 feet higher than the mill. It is reported that



Blair Elevator, Atchison, Kansas, destroyed by fire July 18, 1926. Approximate scale, 1 in. = 75 ft.

within 30 minutes after the elevator fire was discovered 43 shingle roof fires occurred and that there were altogether approximately 60 of these fires. Five of the fires caused considerable losses, while the others were extinguished during their incipiency. All the fires were in a north-northeast direction from the elevator, showing that the embers had been carried with the wind. Embers caused damage to property two miles from the elevator and some embers were found as much as six miles away. It was noted that buildings a distance away were more affected by flying brands than those near to the elevator.

These numerous fires diverted much of the fire equipment from the main fire. One pumper left to put out a dwelling fire but arrived too late to save the building. Following this the pumper's propelling equipment being disabled, it was pushed by citizens to a frame vinegar factory which, however, was a total loss. In both cases the pumper prevented the fires from spreading.

Both combination chemical and hose wagons were taken away from the main fire to handle roof fires in other parts of the city. One of the pumping engines from St. Joseph, Mo., was also used to fight a serious fire in a large shingle roofed garage and numerous smaller fires. Although couplings of the St. Joseph Fire Department would not fit the Atchison

hydrants, the Atchison department had adapters which enabled the St. Joseph Department to use their equipment.

Approximately 300 volunteers assisted the fire department, using commercial trucks, fire department equipment, ladders, and garden hose, patrolling the exposed part of the city, and extinguishing numerous fires. This shows how many people are needed to take care of fires which may be caused by flying brands.

Due to the crowding of the streets surrounding the elevator by automobiles, the fire department was at first very much hampered in getting to these various fires. Undoubtedly, however, due to the efforts of the fire departments and citizens, a serious conflagration was barely averted. The losses caused by the shingle roof fires were considerable, amounting to about $60,000 in all; the principal losses being in two residences, a vinegar works, a garage and a paint shop. In every one of these cases the building involved had a wooden shingle roof.

Conclusions.

Among other lessons of this fire are the following:

1. Frequent inspection should be made of isolated parts of plants if hazardous machinery is located in such places. If an oiler had made his regular rounds which would have included the machinery in the cupola, and on his leaving the watchman had commenced his rounds, the fire would probably have been discovered early enough to have been extinguished by first aid appliances.

2. Conveyor galleries should be cut off by standard automatic closing fire doors and shutters on both sides of walls.

3. High buildings should be provided with outside means of ingress, such as permanently attached iron ladders to permit the closing of windows and doors at communications to other buildings and the fighting of fires at the time of their incipiency.

4. Grain bins in all types of buildings should be tightly decked with the same material used in the construction of the buildings.

5. Hose couplings should be standardized so far as possible in order to enable outside assistance to operate with as little loss of time as possible.

6. The wooden shingle should be eliminated as it spreads fires too fast for a fire department to cope with them.

Fires in Which There Was Loss of Life.

These notes are intended to point out typical conditions under which loss of life has occurred, that they may be known and guarded against.

Children—Matches.

L-45. MARLBORO, MASS., JULY 7, 1926. A three-year-old girl set her clothing afire while playing with matches. Her parents did not reach her until she had been so severely burned about the body, feet and legs that she died two days later.

L-46. SALEM, MASS., JULY 16, 1926. Several children were playing with matches in a yard when the clothes of a five-year-old girl took fire. Her mother was badly burned in extinguishing the flames. The girl's burns were so severe they caused her death two days later.

L-48. PORTLAND, ME., JULY 16, 1926. Two children, a boy 5, and his sister, 13, were left alone while their mother went on an errand. The younger, playing with matches, set fire to some combustible furnishings. The girl rushed out and alarmed neighbors and then remembering her brother, went back to rescue him. The bodies of both children were found when firemen arrived.

Flammable Refrigerant.

H-23553. HARTFORD, CONN., JULY 19, 1926. A workman had been called to repair a "master" refrigeration plant in an apartment house. The plant used ethyl chloride in the refrigerating process. Fumes of this ignited from a nearby gas stove and the ensuing explosion killed the workman. This is the second fire from this type of refrigerating unit which has occurred in Hartford. The fire chief says that the distributors of this make of refrigeration plant are abandoning the use of ethyl chloride as a result of this fire experience.

Trapped in Burning Building.

H-23582. BOSTON, MASS., JULY 17, 1926. A painter was trapped on the third floor of a fashionable Beacon Street residence which was being renovated. The fire is thought to have been due to the ignition of fumes from paint remover by the arcing of an electric switch. Flames spread rapidly through the five floors, cutting off escape of a dozen workmen. Those on lower floors jumped from windows and two men on the third floor got down a waterspout. Suffocation caused the death of the trapped painter.

Gasoline.

H-23471. WATERTOWN, MASS., JUNE 26, 1926. Two boys were playing at a gasoline filling station. Seizing a gasoline hose which was running from a tank truck to an underground tank, one of them turned

it on the other, drenching him. This lad, thinking nothing of his drenching, was a few minutes later playing with a cap pistol. On firing it the spark set his saturated clothes ablaze. The boy ran a short distance to his home where his father put out the flames. The lad died a few hours later at a hospital.

H-23677. MILFORD, CONN., AUGUST 22, 1926. A young man was using a gasoline spraying machine in cleaning an automobile motor. A chance spark of some sort ignited the gasoline spray and the man was enveloped in flames and burned fatally.

L-59. NEWTON, MASS., SEPTEMBER 7, 1926. Two boys, 9 and 10 years old, were playing with a can full of gasoline and one had splashed the other with some of it. Pouring the remaining liquid into an old oil stove in their backyard they attempted to light it. The boy's saturated clothes ignited and although he promptly pulled them off while the other turned a garden hose on him, the burns were fatal.

Kerosene.

L-57. SIDNEY, N. S., JULY 17, 1926. While a woman was using kerosene to light the kitchen fire it exploded, igniting her clothes. She threw herself into a cotton hammock which served only to add fuel to the flames. Neighbors finally rescued her and put out the fire, but her burns were fatal.

L-58. SIDNEY, N. S., AUGUST 10, 1926. A woman was pouring oil on a slow kitchen fire. This caused an explosion which set her clothing afire. Despite immediate aid and care she died from her burns.

Sparklers.

L-53. BAR HARBOR, ME., JULY 5, 1926. A three-year-old girl holding a "sparkler" ignited the clothing of her 16-year-old sister, who was burned fatally.

L-44. NORTH ATTLEBORO, MASS., JULY 7, 1926. A two-year-old girl set her clothes on fire from a "sparkler" which she was holding. She died shortly after at a hospital.

Other Fireworks.

L-43. PROVIDENCE, R. I., JUNE 29, 1926. Two children were badly burned and their father fatally, when they threw some fireworks, which they had found, on the breakfast table. Cigarettes on the table are supposed to have ignited the fireworks which exploded.

H-23666. BRISTOL, R. I., AUGUST 9, 1926. The explosion of a fireworks plant caused the death of the owner, his wife, son and son-in-law. The plant was a mere shack, but the explosion wrecked two neighboring dwellings as well, breaking windows in buildings as much as a mile distant. No cause for the explosion is known.